WSF 2017

6th World Sustainability Forum

27 – 28 January 2017
Cape Sun Hotel
Cape Town, South Africa

Programme and Abstract Book

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Welcome by Beverly Damonse

The quest towards and for sustainability in Africa, in its broadest sense, is guided by recent comprehensive global and African policy instruments, which includes the United Nation's Agenda 2030, the African Union's Agenda 2063, and especially the Science, Technology and Innovation Strategy for Africa (STISA 2024). These provide context within which progress in attaining sustainable development for improved quality of life can be collectively implemented, measured, and monitored at all levels of society. The role of STI in supporting and catalyzing sustainability cannot be underestimated, and has increasingly been highlighted. Indeed, the successful implementation of the policy instruments mentioned will be directly influenced by the inclusivity, innovation and collective action of science, and the research endeavor, for its success. Public funding agencies, like the National Research Foundation (NRF) of South Africa, play a significant national and increasingly global role in providing an enabling environment for research excellence that supports sustainability. It is in this context that the NRF is delighted and honored to be a strategic partner in hosting the 6th World Sustainability Forum on the African continent.

Science Granting Councils continue supporting researchers to shape the global agenda for sustainability as performers, advisers, and collaborators across all spheres of influence. The 70th General Assembly of the United Nations designated 2017 as the *International Year of Sustainable Tourism for Development*. Further extrapolated, the approach will provide (1) Inclusive and sustainable economic growth; (2) Social inclusiveness, employment and poverty reduction; (3) Resource efficiency, environmental protection and climate change; (4) Cultural values, diversity and heritage; and (5) Mutual understanding, peace and security – all of which are applicable to any range of disciplines to contribute to society's development for the future. Using these five key areas as broad guidelines, the NRF will continue to support cutting-edge research in stimulating knowledge creation, in advancing systems of innovation in Africa, and increasingly contribute towards the global knowledge agenda.

As evident from the rich range of abstracts submitted, discussions must also focus on capacity factors for our systems of innovation, especially in the African context. Momentum must be enhanced for our combined and innovative efforts in nurturing the next generation of researchers through

harnessing international partnerships, increasing investments in the resourcing of this endeavor, and ensuring the production of 'fit for purpose' researchers to support and lead the immense task of addressing sustainability research from transdisciplinary, impact oriented, and collaborative perspectives.

The input of science to the sustainability discourse will only be sustainable in itself when and if the gender dimension cuts across all approaches. This aspect of diversity, among other factors, will contribute to the composition of resourceful research and management teams leading to better research outcomes. By asking gendered research questions, the results, findings, conclusions, and resultant products and services will take into consideration the abilities, needs, and concerns of both women and men, ensuring inclusive research and innovation.

The conference brings together researchers, policymakers, practitioners, private sector and civil society actors – all of them strategic stakeholders to ignite conversations and stimulate actions for our combined efforts in not only knowledge generation, but also capacitating our systems of innovation to effectively contribute to the sustainability discourse; and ultimately to our collective future.

Dr Beverly Damonse
Group Executive Science Engagement and Corporate Relations
National Research Foundation, South Africa

Welcome by Adipala Ekwamu

The 6th World Sustainability Forum is taking place for the first time in Africa – early in the journey towards the 2030 Agenda for Sustainable Development. With over a decade to 2030, we have the opportunity to reflect and set the direction and pace for the accelerated achievement of the set targets. Africa's population recently surpassed 1 billion people, and is estimated to more than double by the year 2050. Capacity building through higher education, and particularly postgraduate education – and greater knowledge production – will be critical to the articulation and realization of the Sustainable Development Goals.

Education for sustainable development is a dynamic concept that encompasses a new vision for education: an education that can shape the world of tomorrow, equipping individuals and societies with the skills, perspectives, knowledge and value to live and work in a sustainable manner; and an education that seeks to balance human and economic well-being with cultural tradition and respect for all resources. It should therefore be the focus of tertiary education institutions for developing the required behaviour towards sustainability.

Sustainable development is an open-ended process, a vision that society must work towards, which may manifest in different ways and in different contexts. Humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs.

Higher education has an important responsibility to develop ideas and knowledge for improving Africa's social and economic conditions for the sustainable development of Africa. Higher education institutions are better suited as agents of change and attaining sustainable development because they are closer to grass roots for education, training, and consultancy functions (Scott and Gough, 2006). The goal of higher education is to develop skills for life-long learning, and it is the institutions' responsibility to empower students to become active in their paths of discovery, both at the level of subject expertise and the application of knowledge. Collaboratively and individually, education in higher education institutions is not simply about knowledge transfer and skills enhancement – it is also about working

with people to take charge of their own lives in a shared world. It is also about emancipation and social relevance in its broadest sense.

Given the development challenges in developing countries such as energy (characterized by over-consumption of low grade traditional energy resources, contributing to soil erosion, reduced soil fertility and desertification encroachment); climate change; corruption; and diseases; the role of higher education in empowering citizens to develop and implement new and innovative strategies that are based on science needs to be better articulated.

The abstracts demonstrate the important contribution that knowledge can make towards sustainable development in Africa, and indeed the World, through innovation. The abstracts also show the importance and relevance of science, technology and innovation to enhancing sustainable development on the continent.

Prof Adipala Ekwamu
Executive Secretary
Regional Universities Forum for Capacity Building in Agriculture (RUFORUM)

Welcome from the Chairs of the 6th World Sustainability Forum

The adoption of the 17 United Nations Sustainable Development Goals and the 2030 Agenda for Sustainable Development in September 2015 was accompanied by what insiders considered an optimism they have not experienced in relation to UN resolutions before. The relative efficiency in the drafting, the lack of trenches between East and West, or between North and South, and the unanimity of support of the 193 countries speak volumes. In stark contrast, sustainability and dealing with it could be the poster child for what Robert Horn called a social mess (2007: 6): "a set of interrelated problems … resistant to analysis and, more importantly, to resolution." Characteristics of a social mess generally, and sustainability specifically, include an absence of a unique and correct solution, interrelatedness of problems, ideological constraints, multiple possible intervention points, resistance to change, value conflict, and political and economic constraints. While these are excellent ingredients for a thorough academic debate, the issues underpinning the sustainability debate are so urgent that, beyond academic reflection and research, much more is necessary than what academics, political leaders, administrators, industry, nations, communities, and individuals are habitually prepared to do.

Based on the Johannesburg Declaration on Sustainable Development, adopted at the World Summit on Sustainable Development in 2002, sustainability refers to the "collective responsibility to advance and strengthen the interdependent and mutually reinforcing pillars of sustainable development — economic development, social development and environmental protection — at the local, national, regional and global levels." Conference topics at this forum may include food, nutrition, agriculture, water, mining, technology, energy, economics, sustainable cities, land management, migration, lifestyles and consumption, business and management, and corruption.

The *6th World Sustainability Forum*, for the first time held in Africa, contributes to international debates on sustainability and, more specifically, enables exchanges, which sensitise the international community to the urgency, specifics, and existent knowledge base of sustainability on the

African continent, and the African research community about international perspectives on sustainability. To do justice to the topic, we included contributions not only from national and international academic perspectives, but we have also attracted a diverse audience that includes members from the political and business sectors. For better or worse, the next few decades will be marked by a profound engagement in sustainability research and policy – and Africa is profoundly influencing and being influenced by global developments. In stark contrast, sustainability seems to go against a changing economic and political tide, where waves of nationalism and protectionism from some of the most powerful countries risk the wellbeing of the rest of the world.

This is an excellent opportunity for researchers, practitioners, and policy makers to engage with this topic, to become aware of the urgency of the issues, and to recognize individual, collective, and national opportunities associated therewith.

Aldo Stroebel, National Research Foundation of South Africa
Thandi Mgwebi, University of the Western Cape
Mark New, University of Cape Town
Manfred Max Bergman, University of Basel

Main Speakers

HE Helene Budliger Artieda
Ambassador of Switzerland to the Republic of South Africa

Prof Jeffrey D. Sachs
Director of The Earth Institute, Quetelet Professor of Sustainable Development, and Professor of Health Policy and Management, Columbia University, USA

Prof Tyrone Pretorious
Rector and Vice-Chancellor, University of the Western Cape, South Africa

Prof Daya Reddy
President-elect, International Council for Science (ICSU); Professor of Computation Mechanics, University of Cape Town, South Africa

Prof Frans Swanepoel
Professor Future Africa, Centre for the Advancement of Scholarship, University of Pretoria, South Africa

Ms Joyene Isaacs
Head of Department, Western Cape Department of Agriculture, South Africa

Prof Lidia Brito
Director of the Division of Science Policy and Sustainable Development, UNESCO, France; Director of Help the Afghan Children (HTAC), Uruguay

Prof Klaus Leisinger
President of the Global Values Alliance Foundation; Professor of Sociology, University of Basel, Switzerland

Dr Sylvester Mpandeli
Reserach Manager, Water Utilisation in Agriculture
Water Research Commission, South Africa

Prof Masafumi Nagao
Visiting Professor and Programme Adviser, Institute for the Advanced Study of Sustainability, United Nations University, Japan

Prof Mamokgethi Phakeng
DVC Research and Internationalisation, University of Cape Town, South Africa

Prof Teboho Moja
Professor in Higher Education, New York University, USA

Prof Norman Duncan
Vice-Principal, University of Pretoria, South Africa

Ms Bongiwe Njobe
Executive Director (Founder), ZANAC Foundation

Prof Lise Korsten
Co-Chair of the Centre of Excellence in Food Security, University of Pretoria, South Africa

Prof Francis Petersen
DVC Institutional Innovation, University of Cape Town; and Vice-Chancellor-designate, University of the Free State, South Africa

Prof Voster Muchenje
Chair in Food Security, University of Fort Hare, South Africa

Prof. Manfred Max Bergman
Social Research and Methodology
University of Basel
Petersgraben 11
4051 Basel, Switzerland
Max.Bergman@unibas.ch

Prof.Klaus Leisinger
Global Values Alliance
Schönbeinstrasse 23
4056 Basel, Switzerlan
info@globalvaluesalliance.ch

THE SUSTAINABLE CORPORATE RESPONSIBILITY (SCORE) GROUP

The Sustainable Corporate Responsibility (SCORE) Group, directed by Prof. Manfred Max Bergman (University of Basel) and Prof. Klaus Leisinger (University of Basel; Global Values Alliance), is dedicated to empirical research on the complex relations between business and society from a culture-sensitive and context-specific perspective.

As a member of the UN Sustainable Development Solutions Network (UN SDSN), SCORE is studying the ways and means the SDG process is utilized to further inclusive and green economic development, foster social development, and improve environmental management. In this regard, the SCORE group is currently exploring the roles and responsibilities of corporations in and beyond regions and societies. It also compiles and analyses the corporate responsibility expectations of relevant stakeholders from government, NGOs/NPOs, and civil society.

The aim of the research programme is not only to advance theories and research on corporate sustainability in cross-national and crosscultural contexts but also to facilitate change. Examples of important research questions are: Why and how should corporations be responsible? What are the corporate responsibility expectations of important stakeholder groups? Why are some corporations more committed to sustainable development than others? What are the advantages of, and the main hurdles toward, integrating international commitments (e.g. UN Global Compact; UN SDGs)? By focusing on such questions, SCORE aims to contribute to policy-relevant and future-oriented research that will help to improve global relations between business and society – and thus facilitate sustainable development through co-creation.

Acknowledgments

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Organizers

The University of the Western Cape is a national university, alert to its African and international context as it strives to be a place of quality, a place to grow. It is committed to excellence in teaching, learning and research, to nurturing the cultural diversity of South Africa, and to responding in critical and creative ways to the needs of a society in transition.

As an entity of the Department of Science and Technology (DST), the National Research Foundation of South Africa (NRF) promotes and supports research through funding, human resource development and the provision of National Research Facilities in all fields of natural and social sciences, humanities and technology. The NRF provides services to the research community especially at Higher Education Institutions (HEIs) and Science Councils, with a view to promote high-level human capital development. The NRF aims to uphold excellence in all its investments in knowledge, people and infrastructure.

Founded in 1829, UCT has a proud tradition of academic excellence and effecting social change and development through its pioneering scholarship, faculty and students. It is also renowned for its striking beauty, with its campus located at the foot of Table Mountain's Devil's Peak, with panoramic views of much of Cape Town.

The university opened with a mass held at Basel Minster on 4 April 1460. It has undergone dynamic development ever since its inception. During the first year following its founding, the University Register in Basel listed 226 students and lecturers. Today, the seven faculties at the University of Basel have around 13,000 students and over 350 professors.

Table of Contents

1
General Information

1.1 Conference Venues

The conference will take place at Cape Sun Hotel, Strand Street, Cape Town. From 27 to 28 January 2017 the conference plenary sessions will take place in the VOC centre on the third floor. The parallel sessions will take place on the second floor in the Cape Sun Hotel. For 'Lost and Found' items, please contact the registration desk staff.

1.2 Registration Desk times

Friday 27 January 08:00-21:30.
Name badges are to be worn at all times during the conference or entrance to the various talks will not be allowed.

1.3 Wireless Internet Access and Login

Details will be supplied at the Registration Desk.

1.4 Lunch

Lunch will be served on the third floor in front of the VOC Centre.

1.5 Cocktail Function

Thursday 26 January 18:00-19:30.
World Sustainability Forum 2017 Cocktail Event, Cape Sun Hotel, Cape Town.

1.6 Conference Dinner

Friday 27 January 2017 at the Gold Restaurant, 15 Bennett Street, Green Point, 8005, Cape Town.
Please ensure, when attending the dinner on the Thursday evening, that you bring along your dinner ticket.
Transport will be provided from Cape Sun Hotel at 18:30. Return transfer will also be provided.

1.7 Audio Visual Presentations

Presentations should be handed to the Audio Visual staff on a memory stick/flash drive in the various meeting rooms, during the break prior to your talk. Please inform the technician in the venue if your presentation has sound or video clips.

1.8 Language

The official conference language will be English.

1.9 Emergency Contact Numbers
Police: 10111 | Ambulance: 10177 |
Cape Town International Airport: 021 937 1200

1.10 Cape Town
Cape Town and the Western Cape are considered among the most beautiful areas in Africa. Characterised by a cultural melting pot of Indonesian, French, Dutch, British and German settlers; the local Khoisan (Bushman and Hottentot) tribes and the Bantu tribes from the north; the pristine coastline with its white sandy beaches; the magnificent countryside with its bountiful rivers, wetlands and dams, and the unique flora kingdom; together with a "Mediterranean-like" climate and friendly community, make it the perfect destination for any visitor. Cape Town is the legislative capital of South Africa, and the historic buildings of the Houses of Parliament are situated in the Cape Town city centre. Situated at the foot of Table Mountain, the Cape Town Central Business District is a relatively small area, which allows for easy exploration on foot. Numerous excellent hotels, loft apartments, trendy restaurants and bars can be found in the heart of the city and along the coast. Take a trip up Table Mountain; visit the Victoria and Alfred (V&A) Waterfront, with over 270 shops, a wide selection of restaurants and art and craft markets. Last, but not least, take a trip to Robben Island, where Nelson Mandela was formerly incarcerated. The City Central area offers a wide range of attractions and activities and the visitor can experience the "Mother City" at her best.

1.11 Airport Transfers and Tours

For information or to book airport transfers, contact Marlyn Adriaanse of Kingdom Tours on: Email: info@kingdomtt.co.za / Tel: 021 705 6177, Cell: 083 306 0550.

Various tour options are also available on the site: www.kingdomtt.co.za.

1.12 Hotels

Please note that check-in time at guest houses and hotels is usually after 14:00. If you arrive early and your room is not available, ask your guest house/hotel to store your luggage until you are able to check in.

1.13 Currency and Banks

The unit of currency in South Africa is the South African Rand (ZAR) and is indicated with a capital R so that, for example, three Rand and fifty cents would be written R3.50. South Africa has a decimal currency system with one Rand equalling 100 cents. Denomination of Rand notes are R200, R100, R50, R20, and R10 and of the coins are R5, R2, R1, 50c, 20c and 10c. The following exchange rates were applicable at the time of sending out this document: 1 United States Dollar = ZAR 14.00 | 1 Euro = ZAR 16.00

Facilities for cashing traveller's cheques are available at banks (operating hours are Monday-Friday 09:00-15:30; Saturdays 08:30-11:00) and at most hotels. Banks are closed on Sundays. Foreign exchange agencies are open during the week and on Saturdays. Most Automatic Teller Machines (ATM) are open 24 hours and are located at most banks. International credit cards (Visa, Diners Club, MasterCard and American Express) are accepted at the majority of hotels, restaurants and shops.

1.14 Taxi Services

The taxi rate varies between companies and runs at about R10/km and it is advisable to ask for a fare estimate before you agree. Unicab – 0822 250 250 / Elite Taxi – 0861 635 483 / Cab Express – 021 448 1616 / Exite Taxi - 021 448 4444 / Affordable taxi – 072 296 3518 / Cabs on Call – 021 522 6103 / Grab a Cab – 021 556 6344 / Marine taxi – 021 434 0434 / Sea Point taxi – 021 434 4444 / Rikki Taxi – 0861 745 547.

The MyCiTi bus goes into the city (Civic Centre and V&A Waterfront). The airport service operates between 20 and 24 hours a day at a cost of R57.00 one way. It departs every six to 30 minutes, depending on demand. MyCiTi bus also has a wide network of routes in and around the city.

You will be able to purchase this bus card at the airport, and load money onto the card for a single/return trip. For more details regarding fares, go to: http://sci.fo/2w8.

1.15 Electricity Supply

The electricity supply in South Africa is 220-240 volts, 50 Hz. The connection for appliances is a round three-pin plug. Most hotels provide dual-voltage two-pin razor sockets (100-120 volts and 220-240 volts). Adaptors will be on loan from the registration desk.

1.16 Health

There are no compulsory vaccination requirements for persons entering South Africa, although a certificate for yellow fever may be required if you are entering from certain South American or sub-Saharan African countries. Certain parts of the country have been designated as malaria risk areas. If you intend to travel to one of these areas, it is essential that you take prophylaxis before arrival and whilst in the area. Protective clothing and insect repellents should also be used. Cape Town is a malaria risk free area. South African doctors and dentists are highly trained professionals and hospitals are well-equipped. Participants are requested to make their own arrangements with respect to health insurance prior to departure and consult their local general practitioner for personal expert advice. For international travel and health advisories please visit the WHO website at www.who.int/ith or www.cdc.org. It is safe to drink tap water throughout South Africa. However, for those who prefer bottled mineral water, this is readily available in various stores. Smoking is prohibited by law in most public buildings in South Africa (Airports, Cape Town International Convention Centre, Restaurants etc.) except in designated smoking areas.

1.17 Insurance

The World Sustainability Forum accepts no liability for any personal injury, loss or damage of property belonging to or additional expenses incurred by congress participants either during the congress or as a result of delays, strikes or any other circumstances.

Participants are requested to make their own arrangements with respect to health and travel insurance.

1.18 Security

For those participants who have not previously visited South Africa, or Cape Town, and are concerned about personal safety, we wish to assure all visitors that Cape Town is like any other major city with areas with greater or reduced risk of crime. Common sense will ensure a trouble-free and enjoyable congress and vacation. The area around Cape Town, and adjacent hotels is safe and well-monitored at all times but we advise that you do not walk alone after dark in unpopulated streets. Ostentatious displays of wealth should be avoided at all times. During the conference, the information desk at the conference and your hotel's concierge will be able to assist you with information on places to visit and the appropriate means of transport.

1.19 Shopping in Cape Town

Most shops in the city centre and suburbs open between 08:00-17:00 to 17:30. Shops in major shopping malls open at 09:00 and close at 19:00 or later (especially at the V&A Waterfront), even on Sundays and most public holidays. Government agencies still keep to traditional weekday only hours. Most banks close at 15:30, and have limited Saturday morning opening times. Muslim-owned businesses close at noon on Fridays and re-open at 13:00.

1.20 Tipping

Gratuities are expected in South Africa. A guideline for visitors is the following: Airport porters ZAR 5.00 per item, taxis 10%, waiters and waitresses in restaurants 10%.

1.21 Traveller's Cheques

Most international traveller's cheques are accepted, provided they are in an acceptable currency and may be cashed at most banks. Many hotels and shops also provide this service.

1.22 VAT / Tax Refunds

VAT of 14% is levied on nearly all goods and services. Foreign tourists may claim back VAT paid on items that will be taken out of the country. Original tax invoices, foreign passport, plus all the items on which a refund is claimed, must be presented at the VAT Refund Administration Office or an appointed RSA Customs and Excise Official on departure, and the total VAT on these items will be refunded.

1.23 Weather

Dawn arrives just before 07:00 and the sunsets at around 19:30. The weather is generally fair but occasional rainy and windy days can occur. Mornings are cool in the early morning and moderately hot towards the afternoon, evenings can be cool especially if there is a breeze. Maximum daytime temperatures range from 20ºC to 33ºC.

We thoroughly look forward to welcoming you in Cape Town! Members of the Local Organising Committee, and Conference Management Centre

1.24 Location

1.25 Directions to Cape Sun Hotel, Cape Town

Physical Address: Strand Street, Cape Town 8001
Telephone: +27 21 488 5100; Fax: +27 21 423 8875
Email: sscapesun.reservations@tsogosun.com
GPS Coordinates: 33°55'17.29'' S | 18°25'18.73'' E
From The Airport: Take N2 to Cape Town. Follow until Strand st. turnoff to the city. Cross 3 traffic lights & the hotel is on the left side.

Publication Opportunities: MPDI's Sustainability Publications

MDPI SUSTAINABILITY FOUNDATION

MDPI

Participants of the 2017 *World Sustainability Forum* are kindly invited to submit their contributions for publication with MDPI:

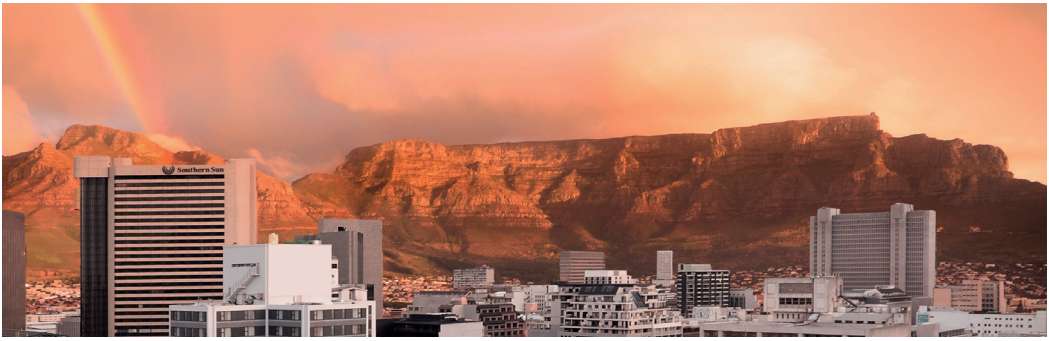
- as a Special Issue paper in the open access journal *Sustainability*
- as a chapter in the second edition of MDPI's open access book series on *Frontiers in Sustainability (FinS)*, guest-edited by Manfred Max Bergman (Chair of Social Research and Methodology, University of Basel, and *World Sustainability Forum* Chair)

Sustainability

Sustainability (ISSN 2071-1050) is an international, cross-disciplinary, scholarly and open access journal of environmental, cultural, economic, and social sustainability of human beings. *Sustainability* provides an advanced forum for studies related to sustainability and sustainable development, and is published monthly online by MDPI. It publishes reviews, regular research papers, communications and short notes, and there is no restriction on the length of the papers. *Sustainability* is covered by both SCIE and SSCI (Web of Science) and has an impact factor of 1.343 for 2015, which ranks *Sustainability* as 176 out of 223 journals in the field of Environmental Sciences (Journal Citation Report Science Edition). In order to cover the costs of providing and maintaining a publication infrastructure, managing the journal, and processing the manuscripts through peer-review and the editorial procedure, authors are asked to pay an Article Processing Charge (APC) of 1400 CHF (Swiss Francs) per processed paper, but only if the manuscript is accepted for publication after peer-review and possible revision of the manuscript. Note that many national and private research funding organizations and universities explicitly cover such fees for articles that originate from funded research projects. Discounts are available for authors from institutes that participate in MDPI's membership program.

Please submit your manuscript to the WSF 2017 Special Issue of Sustainability *online via ▸ mdpi.com/journal/sustainability/special_issues/6th_WSF*
before 30 April 2017.

sustainability



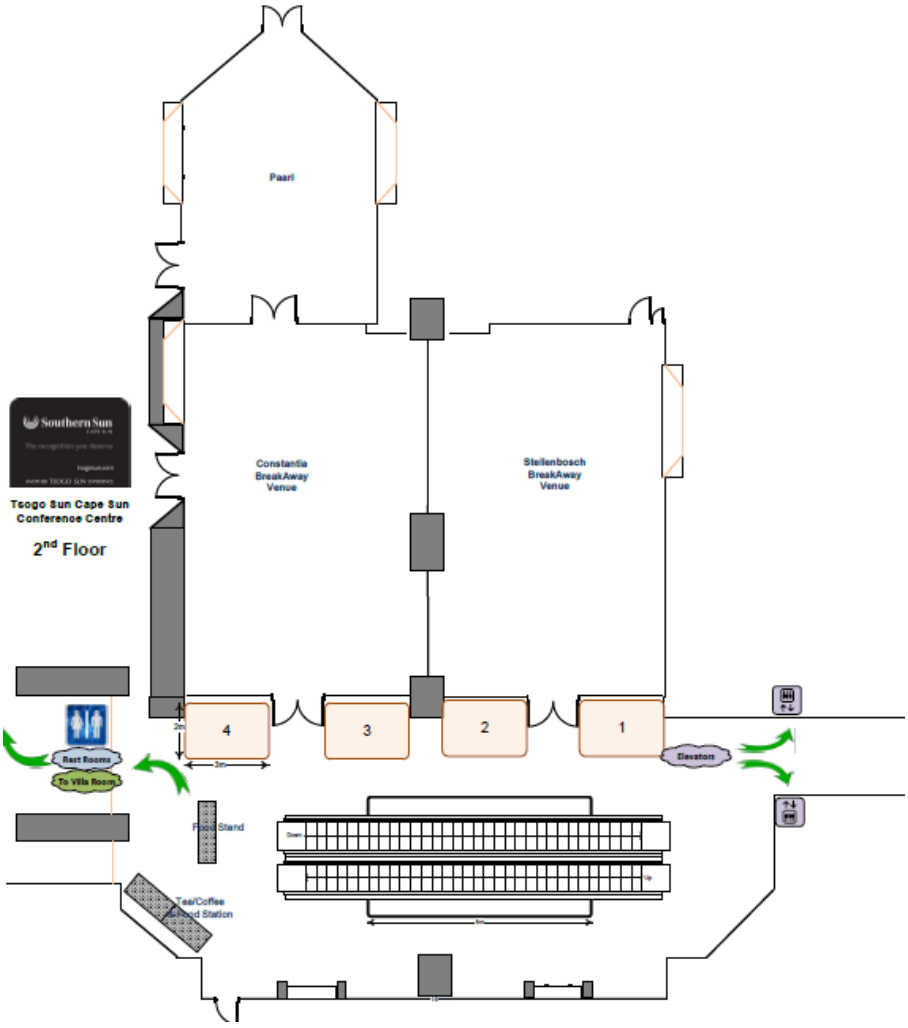
Frontiers in Sustainability (FinS)

The book series *Frontiers in Sustainability (FinS)* serves as a transdisciplinary and multistakeholder platform for regional and global sustainability issues. Here, we understand transdisciplinarity as being a collaboration between researchers from different disciplines to conceptualize, study, and derive solutions to sustainability-relevant problems that may be relevant to stakeholder practices and outcomes beyond academia. *FinS* promotes debates within and between academic disciplines, especially the natural sciences, engineering and technology, and the social sciences, and it seeks to publish academically relevant exchanges between academia, intergovernmental and non-governmental organizations, politics, and business. *FinS* also publishes manuscripts that do not fit the conventional journal format. Apart from theoretical or empirical papers on sustainability, contributions may include tentative policy or position papers, important research updates, opinion pieces, focused literature reviews, descriptions of relevant research or government programs, and other original and creative contributions relating to sustainability. All manuscripts are peer-reviewed. Those accepted for publication in *FinS* will be printed in hardcopy, as well as being available online as open access articles.

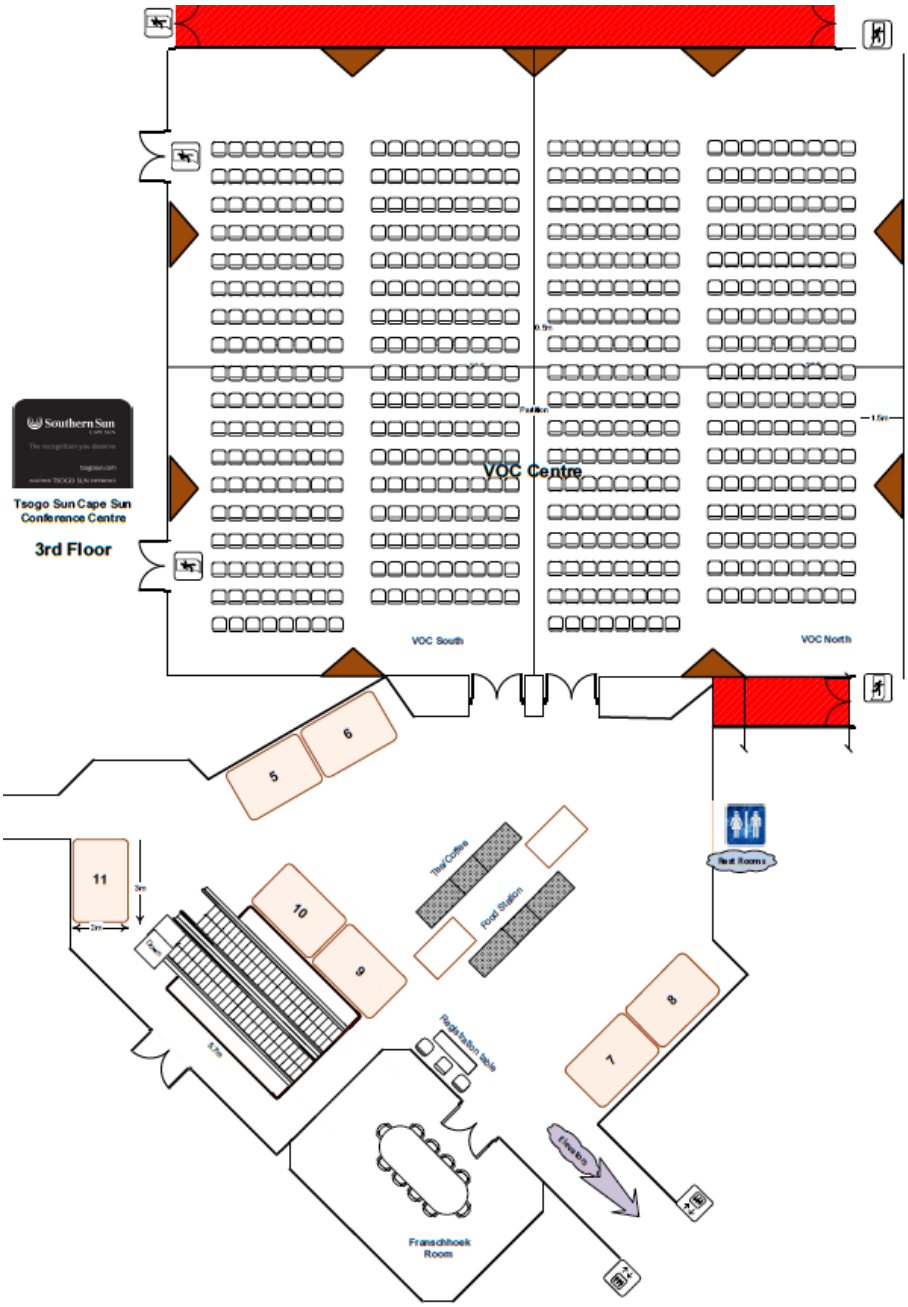
Please submit your manuscript to the second edition of MDPI's open access book series on Frontiers in Sustainability (FinS) *online via* ▸*sciforum.net/conference/wsf-6* **before 30 April 2017.**

2
Conference Venue Floor Plan

2.1 Cape Sun 2nd Floor



2.2 Cape Sun 3rd Floor



3
Conference Programme

Programme Framework – *The 6th World Sustainability Forum* – WSF2017; 27 and 28 January 2017 – Cape Town, South Africa

26 January 2017

18:00-19:30	**World Sustainability Forum 2017 Cocktail Event, Southern Sun Cape Sun Hotel**

27 January 2017

08:00-09:30	Registration	
09:30-11:00	Programme Overview and Introduction of Keynote Speakers	**Chair: Prof Max Bergman** Social Research and Methodology Group (SRaM), University of Basel, Switzerland
	Opening and Welcome	**Prof Tyrone Pretorius** Rector and Vice-Chancellor, University of the Western Cape, South Africa
	Keynote Speaker	**Prof Mamokgethi Phakeng** DVC Research and Internationalisation, University of Cape Town, South Africa
	Opening Address	**HE Helene Budliger Artieda** Ambassador of Switzerland to the Republic of South Africa
11:00-11:20	Break	
11:20-12:40	Plenary Roundtable: Education for Sustainable Development	**Moderator: Prof Teboho Moja** Professor in Higher Education, New York University, USA **Prof Daya Reddy** President-elect of the International Council for Science (ICSU), and Acting DVC, University of Cape Town, South Africa **Dr Lidia Brito** Director of the Division of Science Policy and Sustainable Development of UNESCO, Latin American and The Caribbean, Uruguay **Prof Masafumi Nagao** Visiting Professor and Programme Adviser, Institute for the Advanced Study of Sustainability, United Nations University, Japan **Prof Norman Duncan** Vice-Principal, University of Pretoria, South Africa
12:40-13:30	Lunch	

13:30-14:10	Guest Speaker			**Chair: Prof Max Bergman** Social Research and Methodology Group (SRaM), University of Basel, Switzerland **Prof Jeffrey Sachs** Director of The Earth Institute, Quetelet Professor of Sustainable Development, and Professor of Health Policy and Management, Columbia University, USA		
14:15-16:15	**Chair: Dr Shola Ololade** Water-Energy-Food Nexus: A Local Perspective (Venue: VOC-A)	**Chair: Prof Linus Opara** Sustainable Agriculture: Climate Change and Water-related Issues (Venue: VOC-B)	**Chair: Prof Antonio Frattari** Designing Sustainable Cities (Venue: Paarl)	**Chair: Prof Tim Cresswell** Understanding Mobility Transitions (Venue: Stellenbosch)	**Chair: Prof Mary Scholes** Policy Frameworks for Sustainable Development (Venue: Constantia)	**Chair: Dr Christian Acemah** The Role of Education, Science and Technology in Sustainable Development (Venue: Villa)
16:15-16:45	Break					
16:45-18:15	Plenary Roundtable: Water-Food-Energy Nexus			**Moderator: Prof Frans Swanepoel** Future Africa, Centre for the Advancement of Scholarship, University of Pretoria, South Africa **Joyene Isaacs** Head of the Western Cape Department of Agriculture, South Africa **Prof Lise Korsten** Co-Chair of the Centre of Excellence in Food Security, University of Pretoria, South Africa **Dr Sylvester Mpandeli** Research Manager: Water Utilisation in Agriculture Water Research Commission, South Africa **Prof Voster Muchenje** Chair in Food Security, University of Fort Hare, South Africa		
19:15	Gala Dinner			**Programme Director: Prof Thandi Mgwebi** Director for Research, University of the Western Cape, South Africa **Award of the *World Sustainability Award* and the *Emerging Sustainability Leader Award* funded by the *MDPI Sustainability Foundation* and the MDPI journal *Sustainability*, with acceptance speeches by awardees** **Venue:** Gold Restaurant, 15 Bennett St, Green Point, Cape Town		

28 January 2017

08:00-08:30	Registration					
08:30-10:00	Introduction of Keynote Speakers Keynote Speakers			**Chair: Dr Aldo Stroebel** Executive Director for International Relations and Cooperation, National Research Foundation (NRF), South Africa **Prof Mark New** Pro Vice-Chancellor and Director of the African Climate and Development Initiative (ACDI), University of Cape Town, South Africa **Bongiwe Njobe** Executive Director (Founder), ZANAC Foundation **Prof Klaus Leisinger** President of the Global Values Alliance Foundation; Professor of Sociology, University of Basel, Switzerland **Prof Marc Rosen** Faculty of Engineering and Applied Science, University of Ontario Institute of Technology, Canada and Editor-in-Chief of *Sustainability*, Canada		
10:00-10:30	Break and Poster Presentations					
10:30-12:30	**Chairs: Matthias Stucki and Prof Harro von Blottnitz** Potentialities of Clean Technologies and Management Implications for Sustainable Food Systems (Venue: Stellenbosch)	**Chair: Prof Manfred Fishedick** Climate Change Policy Frameworks (Venue: VOC-A)	**Chair: Prof Alexandros Gasparatos** Solutions for Sustainable Agriculture and Conservation: 1 (Venue: VOC-B)	**Chair: Dr Nadine Sonnenberg** Sustainable Consumption (Venue: Villa)	**Chairs: Prof Nikolaus Kuhn and Dr Henri Rueff** Geography and Environmental Change (Venue: Paarl)	**Chair: Prof Max Bergman** Corporate Sustainability (Venue: Constantia)
12:30-13:30	Lunch					
13:30-15:30	**Chair: Prof Ken Dzama** Sustainable Agriculture and Food Security (Venue: Villa)	**Chair: Prof Voster Muchenje** Responding to Climate Change (Venue: Paarl)	**Chair: Prof Marc Rosen** Sustainable Construction and Manufacturing (Venue: VOC-A)	**Chair: Prof Felix Muesgens** Renewable Energy and housing (Venue: VOC-B)	**Chair: Prof Dee Bradshaw** Mining as a Catalyst for Sustainable Development (Part 1) (Venue: Stellenbosch)	**Chair: Marcel Mballa-Ekobena** Corporate Sustainability and Finance (Venue: Constantia)

<table>
<tr><td>15:30-16:00</td><td colspan="5">Break and Poster Presentations</td></tr>
<tr><td>16:00-17:30</td><td>**Chair: Prof Julian May**
Water-Energy-Food Nexus: A Global Perspective

(Venue: VOC-A)</td><td>**Chair: Prof Neil Armitage**
Developing Sustainable Water Resources

(Venue: Paarl)</td><td>**Chair: Dr Litha Magingxa**
Solutions for Sustainable Agriculture and Conservation: 2

(Venue: VOC-2)</td><td>**Chairs: Dr Sally Stansfield and Dr Oladoyin Odubanjo**
Sustainability and Health
(Venue: Constantia)

Chair: Prof Alexandros Gasparatos
Sustainable Mobility
(Venue: Constantia)</td><td>**Chair: Prof Dee Bradshaw**
Mining as a Catalyst for Sustainable Development (Part 2)

(Venue: Stellenbosch)</td><td>**Chair: Prof Terence Centner**
Sustainable Consumption Regulation and Communication

(Venue: Villa)</td></tr>
<tr><td>17:30-18:00</td><td colspan="3">Closing Plenary: A Future Perspective

Closing Remarks</td><td colspan="2">**Moderator: Dr Aldo Stroebel**
Executive Director for International Relations and Cooperation, National Research Foundation (NRF), South Africa

Prof Francis Petersen
Deputy Vice-Chancellor, University of Cape Town; and Vice-Chancellor-designate, University of the Free State, South Africa

Dr Lidia Brito
Director of the Division of Science Policy and Sustainable Development of UNESCO, Latin American and The Caribbean, Uruguay

Prof Max Bergman
Social Research and Methodology Group (SRaM), University of Basel, Switzerland</td><td></td></tr>
</table>

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3.2 Programme and Venues, Parallel Sessions – WSF2017

3.2.1 Friday, 27 January 2017 - 14:15-16:15		
Venue	**Session Name**	**Chair**
VOC-A	Water-Energy-Food Nexus: A Local Perspective	Dr Shola Ololade
VOC-B	Sustainable Agriculture: Climate Change and Water-related Issues	Prof Linus Opara
Paarl	Designing Sustainable Cities	Prof Antonio Frattari
Stellenbosch	Understanding Mobility Transitions	Prof Tim Cresswell
Constantia	Policy Frameworks for Sustainable Development	Prof Mary Scholes
Villa	The Role of Education, Science and Technology in Sustainable Development	Dr Christian Acemah

3.2.2 Saturday, 28 January 2017 - 10:30-12:30		
Venue	**Session Name**	**Chair**
VOC-A	Climate Change Policy Frameworks	Prof Manfred Fishedick
VOC-B	Solutions for Sustainable Agriculture and Conservation: 1	Prof Alexandros Gasparatos
Paarl	Geography and Environmental Change	Prof Nikolaus Kuhn and Dr Henri Rueff
Stellenbosch	Potentialities of Clean Technologies and Management Implications for Sustainable Food Systems	Matthias Stucki and Prof Harro von Blottnitz
Constantia	Corporate Sustainability	Prof Max Bergman
Villa	Sustainable Consumption	Dr Nadine Sonnenberg

An updated list of Presenters can be found **here**

3.2.3 Saturday, 28 January 2017 - 13:30-15:30		
Venue	**Session Name**	**Chair**
VOC-A	Sustainable Construction and Manufacturing	Prof Marc Rosen
VOC-B	Renewable Energy and housing	Prof Felix Muesgens
Paarl	Responding to Climate Change	Prof Voster Muchenje
Stellenbosch	Mining as a Catalyst for Sustainable Development (Part 1)	Prof Dee Bradshaw
Constantia	Corporate Sustainability and Finance	Marcel Mballa-Ekobena
Villa	Sustainable Agriculture and Food Security	Prof Ken Dzama

3.2.4 Saturday, 28 January 2017 – 16:00-17:30		
Venue	**Session Name**	**Chair**
VOC-A	Water-Energy-Food Nexus: A Global Perspective	Prof Julian May
VOC-B	Solutions for Sustainable Agriculture and Conservation: 2	Dr Litha Magingxa
Paarl	Developing Sustainable Water Resources	Prof Neil Armitage
Stellenbosch	Mining as a Catalyst for Sustainable Development (Part 2)	Prof Dee Bradshaw
Constantia	Sustainability and Health; Sustainable Mobility	Dr Sally Stansfield and Dr Oladoyin Odubanjo; Prof Alexandros Gasparatos
Villa	Sustainable Consumption Regulation and Communication	Prof Terence Centner

An updated list of Presenters can be found **here**

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Prof. Dr. Marc A. Rosen
Faculty of Engineering and Applied Science University of Ontario, Canada

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Our aim is to encourage scientists to publish their experimental and theoretical research relating to natural sciences, social sciences and humanities in as much detail as possible, in order to promote scientific predictions and impact assessments of global change and development.

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- Defining, quantifying, measuring and monitoring sustainability
- Sustainable utilization of resources such as land, water, atmosphere and other biological resources
- Effects of global climate change on development and sustainability
- Sustainable chemistry
- Health-related aspects of sustainability
- Developments in cultural diversity, tradition, social systems, globalization, immigration and settlement, and their impact on cultural or social sustainability
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- Policies and laws relating to sustainability

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4
Oral Presentation Abstracts

1 (Neo)Liberal Mobility Transitions: Downloading and Distributing Responsibility

Peter Adey

Royal Holloway University of London

In this paper we explore what we might call the (neo)liberal logics that have shaped and underscored many of the mobility transition policies we have evaluated across different countries. These logics capture a somewhat inconsistent relationship of the state and local government to transition policy, regulation, and investment, but with a consistent emphasis upon market-based solutions to transition. These are best expressed through an underlying trend for mobility transitions based on economic rationales, which tend to marginalise environmental gains or, at the very least, position them in the peripheries of decision-making. This paper explores how these logics may produce uneven and contradictory consequences, especially to the extent at which we may call or demand that mobility transitions are somehow 'just'. It also asks in what ways we might imagine mobility transitions beyond the logics of neo-liberalism.

2 Global Health Governance and the 2030 Development Agenda: Opportunities and Challenges for Africa

Obijiofor Aginam

Assistant Director, United Nations University-International Institute for Global Health (UNU-IIGH), Kuala Lumpur, Malaysia

The process of reaching a consensus on the Sustainable Development Goals (SDGs) was long, tortuous, and nerve-racking. In the words of one UN policy-making expert, the SDG process "exhibited many of the worst pathologies of UN sausage-making". Influenced by the Report of the Secretary-general's High-Level Panel, the SDGs are driven by five big transformative concepts: leave no one behind; put sustainable development at the core; transform economies for jobs and inclusive growth; build peace and effective, open and accountable institutions for all, and forge a new global partnership. Entitled "Transforming Our World: The 2030 Agenda for Sustainable Development", the Declaration adopted by Heads of State and Government in New York, 25-27 September, 2015 containing 17 sustainable development goals and 169 ambitious targets - lays out an ambitious framework for global development in the next fifteen years. This paper/presentation assesses the possibilities and challenges that SDG#3 (good health and well-being), and its targets poses for African economies.

GOAL 3: Health and Its Targets:

Health is primarily anchored on Goal 3: to "ensure healthy lives and promote well-being for all at all ages". This Goal has 13 ambitious targets ranging from reducing maternal mortality to ending preventable deaths of newborns, ending the epidemics of AIDS, tuberculosis, malaria, and neglected tropical diseases, reducing premature mortality from non-communicable diseases, strengthening the prevention and treatment of substance abuse including narcotic drug abuse and harmful use of alcohol. The other targets include halving the number of injuries from road traffic accidents, ensuring universal access to sexual and reproductive health services, achieving universal health coverage, reducing deaths and illness from pollution, tobacco control, supporting research and development of vaccines and medicines for communicable and non-communicable diseases including access to affordable essential medicines, increased health financing, development

and training, and retention of health workforce in developing countries, and strengthening capacity for early warning, risk reduction and management of national and global health risks.

Is the Universal Agenda of Leaving no One Behind Achievable in 2030?

Goal 3, like the other 16 SDGs, is driven by a universal agenda of "leaving no one behind". 'Leaving no one behind' raises questions about health as a public good underlined two well-known criteria: non-rivalry in consumption and non-excludability. Most debates on the provision of public goods grapple with differences between various groups of actors and their interests and involvement in the public and private sectors of most countries. While governments drive the development process, the private actors (both "for-profit" and "not-for-profit") are increasingly playing a major role. Governance of global health in the post-2015 era must grapple with the mechanics of public-private partnerships in ensuring healthy lives for all of humanity. With deeply embedded interests, structural inequalities, cultural and "idealogical" differences between countries, will this be achievable in 2030? What ought to be the best mechanism to finance Goal 3 and its targets? Is our world now motivated by high level of "enlightened self-interest" and altruism to drive optimism for this Goal and targets? To contextualize these questions more pragmatically, why should the industrialized countries invest in the control/eradication of neglected tropical diseases of the poor - malaria in Africa? Who should incentivize the private sector, especially "Big Pharma" (global pharmaceutical industry) to devote a huge chunk of their Research and Development (R&D) budget to neglected topical diseases - African trypanosomiasis (sleeping sickness); Lymphatic filariasis (elephantiasis); Malaria; Onchocerciasis (river blindness); Schistosomiasis (snail fever); Trachoma, etc. Past efforts by the World Health Organization to tackle these problems through 2 commissions have not catalyzed effective responses: the WHO Commission on Macroeconomics and Health, and the WHO Commission on Social Determinants of Health.

Who should finance the safety nets in the developing and least-developed countries if health or other essential services are commodified through partial or full privatization and commercialization? If this inevitably leads to forms of public-private partnerships, it would inevitably raise questions of transparency and accountability of the private sector. One of the targets of Goal 3 is to provide "access to affordable essential medicines and vaccines, in accordance with the Doha Declaration on the TRIPS Agreement and Public Health, which affirms the right of developing countries to use to the full the

provisions in the Agreement on Trade-Related Aspects of Intellectual Property Rights regarding flexibilities to protect public health…" This raises an age-old question on the impact of trade agreements on public health. Because TRIPS is one of the agreements enforced by the World Trade Organization (WTO), this target must be aligned with Target 17.10 of Goal 17 that aims to "promote a universal, rules-based, open, non-discriminatory and equitable trading system under the World Trade Organization". In all of this, this paper explores the challenges and opportunities for African economies in the post-2030 Development Agenda.

3 Assessing Urban Sustainability: Applying the DSR Framework in Urban Areas by Incorporating Remote Sensing Technologies

Yusuf A. Aina[1, 2], Alex Wafer[2], Habib M. Alshuwaikhat[3]

[1] Yanbu Industrial College; [2] University of the Witwatersrand; [3] King Fahd University of Petroleum and Minerals

Urban sustainability has gained research focus due to the fact that a large percentage of the world population lives in urban areas and urbanization influences global environmental change. The unsustainable development of urban areas would have implications that would undermine global sustainable development. Current debates on urban sustainability are about developing an operational framework for measuring and benchmarking the sustainability of urban areas. Different frameworks have been developed for sustainability assessment. The frameworks include natural capital, input–output (system model), thematic and issue-based and Driver-State-Response (DSR). The DSR framework has been mainly applied in agriculture and water domains with limited applications in urban areas. The limited use of the framework in urban areas has been due to some shortcomings such as simplification of complex urban systems, focus on a single dimension of sustainability and difficulty in categorizing indicators. This paper revisits the adaptation of the DSR framework for urban sustainability assessment. It reviews the advantages and limitations of different frameworks for assessing urban sustainability and highlights merits of the DSR framework over others in assessing sustainability. This paper also highlights indicators that could be used within the framework to foster urban sustainability by incorporating remote sensing based indicators. Despite its shortcomings, the DSR framework could serve as a simplified way of linking the impacts of urbanization with urban policies. It can also be adaptable to the emerging spatial indicators. The spatial indicators are developed to overcome the problem of scarcity of data by using remote sensing technology to monitor urban environment. There are efforts to also link the indicators to environmental processes rather than measuring a fixed state of the environment. This development could make the DSR framework a useful tool-set for the developing countries where scarcity of data and complexity of urban systems have been the bane of sustainability assessment.

4 Impact of Gas Flaring on the Vitamin Composition of Selected Edible Vegetables in the Niger Delta Area of Nigeria.

Doris Akachukwu[1], Michael Adedapo Gbadegesin[2], Philippa Chinyere Ojimelukwe[3]

[1] Department of Biochemistry, Michael Okpara University of Agriculture Umudike, Nigeria
[2] Department of Biochemistry, Faculty of Basic Medical Sciences, University of Ibadan, Nigeria
[3] Department of Food Science and Technology, Michael Okpara University of Agriculture Umudike, Nigeria

The impact of gas flaring on the climate of the Niger Delta area of Nigeria was studied by evaluating the vitamin composition of selected edible vegetables harvested from gas flaring and non-gas flaring areas using High Pressure Liquid Chromatography (HPLC). The vegetables selected were *Vernonia amygdalina, Occinum gratissmum, Pterocarpus santalinoides* and *Telfairia occidentalis.* The vitamin compositions analysed were vitamins A, B_1, B_2, B_6, C and E. The effect of the gas flaring significantly ($p<0.05$) reduced the composition of vitamins A and B_1 of *Vernonia amygdalina* but a non-significant ($p>0.05$) effect was observed in vitamins B_2, B_6, C and E compared to the control. Vitamins B_1, B_6 and E were significantly ($p<0.05$) different for *Occinum gratissmum* compared to the control, while a non-significant decrease in vitamins A, B_2 and C was observed. There was no significant ($p>0.05$) difference in all the vitamins for *Pterocarpus santalinoides* compared to the control. The effect of gas flaring caused a significant ($p<0.05$) difference in vitamins A, B_2, B_6, C and E in *Telfairia occidentalis* compared to the control. Climate change has been suggested to alter the nutritional composition of plants.

5 Towards Sustainably-Minded Citizens in the Southeastern United States: A Paradigm Shift in Higher Education

Edwin Akins[1], Maria Kalamas Hedden[2], RC Paul[3], Vanessa Slinger-Friedman[4], Roneisha Worthy[5], Pegah Zamani[1]

[1] Dept. of Architecture, Kennesaw State University, Kennesaw, Georgia (USA)
[2] Dept. of Marketing and Professional Sales, Kennesaw State University, Kennesaw, Georgia (USA)
[3] Director of Sustainability, Dept. of Biology, Kennesaw State University, Kennesaw, Georgia (USA)
[4] Dept. of Geography and Anthropology, Kennesaw State University, Kennesaw, Georgia (USA)
[5] Dept. of Civil and Construction Engineering, Kennesaw State University, Kennesaw, Georgia (USA)

The South has been identified as the center of economic growth within the United States (Rines, *The National Interest*, 2014). Accompanying this growth are a variety of views on how society manages the resources needed to serve increasing populations and infrastructural burdens. Given the southeastern region of the U.S. has been relatively slow to develop a strong environmental ethos, sustainability initiatives in higher education help shift the status quo by educating and training tomorrow's workforce.

Kennesaw State University's Sustainability Faculty Fellows program is an effective vehicle for changing social attitudes towards environmental issues by introducing students to sustainability concepts in ways that directly relate to their career goals. Faculty from a variety of disciplines (Architecture, Engineering, Geography, and Marketing) develop curricular changes and student-centered projects that allow students to view sustainability issues in the context of their broader communities.

The *Green Marketing Course*, for example, exposes students to sustainability in business and specific opportunities and challenges marketers face with regards to green issues (e.g., enviropreneurial marketing, greenwashing, etc.). The *Ecological Design Project* examines how green infrastructure can be integrated into a specific site on campus to enrich long-term sustainability. In the *LEED LAB*, students at a public university work with a private college to certify a building and in so doing, take advantage of the

process as a sustainable learning tool. The *Owl Planet Project* engages students and student clubs to promote environmental awareness and implement or support projects that help green the campus. The *ecoPartners Program* proactively addresses equity issues by collectively training environmental change agents, from diverse backgrounds, using a values-based engagement model, placing emphasis on equitable decision-making. Each of these cutting-edge sustainability initiatives blends curriculum and practice, and gives Sustainability Faculty Fellows the opportunity to send better informed citizens into the community and the region's workforce.

6 The Role of Higher Education Institutions in Achieving Sustainable Development Goals (SDGs) in Developing Countries: A Case Study of Green Campus Initiative (GCI) in Nigeria.

Adenike Akinsemolu[1, 2], Toluwanimi Kolawole[3]

[1] The Green Institute
[2] School of Sciences, Obafemi Awolowo University, Adeyemi College of Education, PMB 520 Ondo State, Nigeria
[3] School of Chemical Engineering & Advanced Materials, Newcastle University NE1 7RU

In recent years there has been a considerable drive towards the inclusion of sustainability in higher education institutions' (HEIs) curriculum to train students with the necessary knowledge, skills, and tools to succeed in combating global environmental challenges such as climate change, resource depletion, and waste management amongst others. One of many methods in which HEIs integrate sustainability into their curriculums is through partnerships with so-called green and sustainable initiatives in which students take some courses provided by such initiatives. An example of such an initiative is the Green Campus Initiative (GCI), a community-based sustainability organization located in Ondo state, Nigeria. A study was conducted to measure the impact of integrating sustainability within HEIs' subject disciplines by evaluating the knowledge, skills, competencies and attitudes of participants before and after participating in selected GCI programs. Participants consisted of 600 students of the Adeyemi College of Education Ondo. Participants were drawn randomly from various subject areas within four academic disciplines: humanities, social sciences, natural sciences, and formal sciences. They were trained in sustainable planning, design, development, and management. After the training, students were evaluated for their understanding of the concepts learned in terms of new knowledge and competency obtained from the workshops. The participants were also encouraged to self-reflect on their learning and track their progress. The participants were then evaluated after 52 weeks to track how their learning had impacted their attitudes onwards from the time of the workshops. Results from the study show that students in the natural sciences showed significant improvements in behaviour compared to other

disciplines. However, the study results also revealed that several challenges need to be overcome that limit the impact of these programs, such as lack of structured policies, inadequate awareness, and knowledge amongst others. It is recommended that the HEIs should reflect sustainability in two ways: curriculum and operation.

7 Designing with a Sustainable Approach for Affordable Housing Solutions for Sub-Saharan Africa

Olukayode Olawale Alao

Politecnico di Milano

Housing in Nigeria is capital-intensive and as a result, affordable housing is inaccessible for the average Nigerian. Nigeria's existing housing problems have been further intensified by the continuous population growth; increasing urbanization; the high costs of building materials; the absence of indigenous skills and technology for innovative low-cost housing, coupled with the inadequacy of funding mechanisms provided by financial institutions; and the implications of various government policies. This poses serious concerns for Nigeria's physical development and prospective socio-economic wellbeing. The ramifications of this include, but are not limited to, overcrowding of existing living spaces; poor sanitation; decaying infrastructure; and growing rates of unemployment and under-employment. Infrastructure development is a basic service and serves as a prerequisite for economic development. For this reason, there is a need to find alternative lower cost solutions to address the current qualitative and quantitative housing problems. Our aim is to provide alternative sustainable housing construction methods and material solutions that are best suited for civil infrastructure development in Nigeria (focusing on Lagos State) and extend our reach to the rest of Sub-Saharan Africa. The proposed solution makes use of local building materials and technologies while taking into account the influences of marine and industrial pollution on durability and service life of the proposed housing solution. It further contributes to development through employing local labour and thus facilitates the transfer of skills to the local community.

8 Trends of Climatic Variables and Possible Health Impacts: A Comparative Study of Ghana and Nigeria

Sylvia Ankamah[1], Esimai Peju[2], Sari Kovats[3], Kaku Sagary Nokoe[1]

[1] University of Energy and Natural Resources, Department of Mathematics and Statistics, Ghana
[2] Obafemi Awolowo University, Department of Community Health, Nigeria
[3] London School of Hygiene and Tropical medicine, London, UK

This research aimed at assessing the trend of climatic variables and their possible impacts on health. According to available research, climate change or climate variability affects all life support systems and has far reaching consequences. As such, it is a factor that should be placed high among those that affect human health and survival. One way of assessing climate variability is by assessing the trends.
A Mann-Kendall trend analysis was conducted on data gathered on four climatic variables in the Osogbo Local Government in Nigeria and the Kumasi Metropolitan District in Ghana. The climatic variables include Mean Monthly Rainfall, Mean Monthly Maximum Temperature, Mean Monthly Minimum Temperature, and Relative Humidity for the period between 1986-2015 in both study sites.
Various results were obtained for the trend analysis. Rainfall showed a decreasing trend, though not significant, in Osogbo while it showed a positive trend, although not significant, in Kumasi. Minimum temperature and maximum temperature in Osogbo also showed positive trends, although not significant at the 5% significance level. However, in Kumasi, both maximum and minimum temperature showed increasing trends that were also significant at the 5% significance level. Relative humidity showed a decreasing trend in Osogbo and was statistically significant; it also showed a decreasing trend in Kumasi, although not statistically significant. The implications of these trends on human health are discussed. Conducting studies on the local level basis or that are site specific is important, as it helps policy makers to come out with adaptation and coping strategies specific to those sites.

9 Eco-Nest in the Tropical Sunshine

Shandara Arbab

University of engineering and technology Peshawar, Pakistan

This thesis is based on the reuse of waste materials (plastic bottles, car tyres, used denim) produced in a huge amount on water fronts, polluting the environment and serenity of the area, disturbing the ecology, and affecting the marine life. A sustainable and inexpensive design for houses will preserve the natural ecology of the area and provide a safe living space against oceanic cyclones and flooding to people living permanently on the waterfronts. The theme behind the project is taking back plastic waste from the environment, attributable to human settlements, and reusing it without any extensive and energy consuming recycling process. Eco-nest is a self sustained living module designed for a family of 6–7 people; it is designed with plastic bottles as the building unit and the overall structure is light-weight making it easy to float in the conditions of water level rise or seasonal flooding. The site selected for consideration of the project was that of Mubarak village, Karchi, Pakistan. It is a fishermen community living on the waterfront. They are extremely vulnerable to oceanic cyclones and flooding and there is a chance of permanent sea level rise (environmental study). The settlement has had to experience a huge loss to its economy and livelihood due to seasonal flooding; every year (mid September–mid October) they have to leave their village and businesses and migrate to a safe dry place that damages their livelihood and economy. Tourists to Karachi visit this place during times of pleasant weather and are polluting the natural environment of the area with their disposal of plastic bottles and other waste. The purpose of the project is to utilize that plastic waste and convert it into safe living spaces for the local fishermen, that are safe against the seasonal flooding. An extensive study was carried out regarding waste material construction with the help of case studies and projects carried out in other different countries regarding the subject. The end project achieved from the study was a small prototype living module that floats over the sea; the new settlement is designed to float above the water. The new proposed designs form a floating village consisting of a single module per family and is connected through decks with other modules, hence forming a cluster of eight modules. Each cluster is then connected to another cluster with anchors, and the house of the fisherman also serves as his boat during

floods. All the circulation between the modules and clusters is through decks, whereas in the village, it is through boats, making it a little village similar to Venice. The main target was to achieve a clean and safe environment for the people living there and to improve their social and economic situation. This design will provide a safe solution against sea level rise as the module gradually rises with water rise as well as utilizing the plastic bottles for a good purpose and reducing the pollution caused due to it on water fronts.

10 Coal Fly Ash Beneficiation- Vital for Promoting Environmental Sustainability in Southern Africa

Omotola Babajide[1], Sammy Nyale[2], Nicholas Musyoka[3], Leslie Petrik[1]

[1] University of the Western Cape, South Africa
[2] Council of Geoscience, South Africa
[3] CSIR, South Africa

The generation of electricity from coal in the Republic of South Africa generates million tons of fly ash per annum from the combustion of pulverized coal in its two major power utilities. This residue is known to release toxic elements into the environment after disposal through leaching mechanisms that pollutes soil, surface and ground water. The waste accumulation of fly ash in dumps is a matter of great environmental concern has thus necessitated advanced research on whole beneficiation of fly ash aimed to minimize negative environmental impact. In light of this, this paper gives an overview of various research studies currently carried out within the environmental and nano sciences research group at the University of the Western Cape. An attempt to address the menace of fly ash waste by utilizing scientific engagements while also proffering technical skills in the recycling processes to promote a sustainable South Africa is emphasized in order to meet one of the global goals for sustainable development. The various novel processes developed using waste fly ash as feedstock, firstly for high pure phase zeolites synthesis; secondly as heterogeneous catalyst used in transesterification reactions that has enabled a green biodiesel production to be readily performed as a continuous process resulting in low production costs and thirdly in the production of fly ash-based foamed and non-foamed geopolymers highly beneficial in the building and construction industry aimed to eventually replace cement in a bid to reduce CO2 emissions will be presented. The findings from these studies uniquely demonstrated the utilization of South African Class Fly ash as a rich raw material for zeolite synthesis; established the successful application of both the raw fly ash/ fly ash zeolite material as catalysts in the production of biodiesel and finally verified the hypothesis that it is possible to synthesize foamed and non-foamed geopolymers suitable for building and construction using this same class of fly ash.

11 Treatment of Textile Wastewater in a Combined Hydrodynamic Cavitation, Fenton Process and Nano-Zero Valent Iron (NZVI) System

Kassim Olasunkanmi Badmus[1], Ninette Irakoze[2], Leslie Petrik[1]

[1] Chemistry department, Faculty of Natural Science, University of the Western Cape, South Africa; [2] Chemical Engineering Department, Cape Peninsula University of Technology, Cape Town, South Africa.

The wastewater generated in the textile industries must be treated to ensure efficient reclamation and reuse of the scarce water resources for profitability and effective operation. The state authorities are becoming more conscious of the debilitating effect of organic dye contaminants on the environment and consequently tightening the legal requirement for their discharge. The complex organic dye effluent is an opaque liquid with poor bio-degradability, high chemical stability and persistency, with a concomitantly high cost of treatment. Expensive conventional treatment technologies generate a large amount of unaccounted intermediate products and sludge. However, hydrodynamic cavitation in combination with nano-zero valent iron treatments are novel, advanced oxidation processes (AOP) with diverse reactive OH radical generating capacities. The recent importance of OH radical generating devices is not unconnected with its capability to efficiently mineralize persistent organic pollutants in a non-specific acid mediated reaction. This research established efficient degradation of orange II sodium salt to its mineral form using combined jet-loop hydrodynamic cavitation, Fenton's reagent and nano-zero valent iron (NZVI). The degradation of orange II sodium salt was successfully monitored with a UV spectrophotometer and GC-MS. The degradation conditions, such as pH, amount of the NZVI and initial concentration of dyes, were investigated. This degradation method is comparatively greener, inexpensive and results in the 95% degradation of orange II sodium salt with highly biodegradable and non-toxic intermediate products. Besides, the effluent generated during the degradation can be recycled and reused in industrial processes and fertilizer manufacturing. This result represents a significant progress in the treatment of persistent organic pollutant and textile industry wastewater. The method is recommended for the secondary or tertiary stage of persistent organic pollutant treatment.

12 Waste Paper Biochar as a Sustainable Carbon Black Pigment Replacement in Printing Inks

Steven T. Barber[1], Thomas A. Trabold[2]

[1] Rochester Institute of Technology (RIT)
[2] Golisano Institute for Sustainability (GIS)

Many progressive minded consumers and corporate procurement managers desire to switch to a more environmentally sustainable alternative from modern carbon intensive printing inks but are generally hesitant to do so due to higher prices, lack of product selection and concerns about printing quality. While much has been written on the progress of vegetable (soy) pigment carrier based inks and the sustainability benefits derived from them, little has been discussed about the creation of a more sustainable pigment itself. One of the main reasons for this is that pre-industrial methods of creating ink colorants have largely been forgotten or ignored due to the ubiquity of nonrenewable petroleum derived pigments, such as carbon black. This paper investigates a possible solution to this dilemma by examining the potential for biochars (charcoals derived from organic waste feedstock in pyrolytic conditions) manufactured on an industrial scale and then comminuted to micron level particle sizes using modern wet grinding techniques to replace the carbon black pigments (created by combusting high-viscosity residual fuel oils, #6 or 'Bunker C') used in virtually all black inks today. To do so, waste office paper, cardboard box and paper towel feedstocks were used to create slow pyrolysis biochars at 500 ^{o}C that contained between 92% and 80% carbon and 8% and 20% ash. Subsequently, these biochars were ground, processed and tested for their chemo-physical ability to replace carbon black in household sized ink jet printer inks. Ink made with the biochar pigment replacements were functionally equivalent to their 100% carbon black analogs in terms of print quality tests run. These results help demonstrate the possibility for manufacturers to create an entirely new category of environmentally sustainable and cost-effective inks and inform the direction of future research needed.

13 An Empirical Analysis of DJWSI Data to Determine Industry Specific Global Corporate Sustainability Trends 2005–2016

Steven T. Barber[1, 2], Garrett Macdonald[3]

[1] Rochester Institute of Technology (RIT)
[2] Golisano Institute for Sustainability (GIS)
[3] Three+one Advisors

Many corporate sustainability practice researchers and **CSR** investors seek to understand the overall relative progress in global corporate sustainability efforts over time between industries, but lack credible and comprehensive data to do so. While much has been written on the progress of sustainability of individual industries and the "most sustainable" firms within them, little has been discussed about the relative level of sustainability advancement between all industries. One of the reasons for this is that it is challenging from a practical perspective to assemble the large amount of data necessary across all sectors on a global basis to undertake such a study. A potential solution to this dilemma is to examine the components of the Dow Jones World Sustainability Index (DJWSI), which annually identifies what they consider the most sustainable publicly traded firms globally in all industries via a proprietary online questionnaire administered by RobescoSAM. This paper examines the most statistically significant trends from the inclusion or exclusion of firms in specific industry subcategories of the DJWSI index between 2005 and 2016, and compares this to trend explanations from contemporary corporate sustainability literature. This comparison will help researchers, investors, and corporate sustainability professionals identify and understand why specific sub-industries may have relatively succeeded or fallen behind in their CSR efforts compared with one another.

14 The Mining Industry as a Driver of Innovation Toward the Transition to a Green Economy

Corey Beavon

Minerals to Metals Research Signature Theme, University of Cape Town

This paper will outline what climate change adaptation and mitigation means for the mining sector from community, industry and policy perspectives in South Africa. The paper will highlight opportunities for mining companies to contribute to greenhouse gas (GHG) reduction and the achievement of the Sustainable Development Goals 7(Affordable and Clean Energy) , 9 (Industry, Innovation and Infrastructure) and 13 (Climate Action) through renewable energy transitions. This will be done by providing South African case study examples to demonstrate how mining companies can build resilience to climate action through sustainably orientated innovations while improving their local socio-economic contributions. The potential benefits of these proposed actions will be quantitatively determined in order to create a costs and benefits scenario analysis for the mining industry of South Africa.

As global companies are affected by the current fourth industrial revolution, the mining industry will also be affected. Decarbonising the mineral value chains will require significant industry innovation and adaptation. This paper will identify technologies that will aid the industry transformation to meeting the SDG targets. These technologies include energy efficient transportation through vehicle light weighting and alternative fuel stock supply; renewable energy sources and grid scale energy storage. The transition to renewable energy is not necessarily negative for the mining industry as the minerals and metals required for the creation of renewable energy generation systems will boost the industry, and create changes in the demand of minerals and metals.

Regardless of cyclical commodity shifts, the mining and metals industry will continue to exist into the foreseeable future. The industry is undergoing and will continue to go through significant changes in order to remain viable. We need to ensure that industry transitions are in line with the global development agenda of 2030, and this can be aided through evidence based research. Consequently this paper will provide insight into how the mining and metals industry will respond to global drivers.

15 Involvement of Chinese Corporations in Africa from the Chinese Perspective

Lena Berger, Jin Ding, Laura Lämmli, Manfred Max Bergman

University of Basel, Switzerland

China has become Africa's largest trading partner, and Chinese investments in Africa continue to grow at a rapid pace, rising from 7 billion USD (United States Dollars) in 2008 to 39.8 billion USD in 2015. Accordingly, the role and investments of Chinese corporations in Africa have become intensively discussed topics. In this paper, we combine theories of corporate sustainability with a development perspective to investigate the Chinese involvement in Africa from a Chinese perspective. More specifically, we explore how the involvement of corporations in Africa is portrayed in the Chinese media and how it relates to the role that corporations play in other contexts. The purpose of this study is to map the goals, mechanisms, and effects of the involvement of Chinese corporations in Africa from a Chinese perspective and, in doing so, contribute to a better understanding of the business and societal climate between Africa and China and the factors that facilitate and shape the association between the two parties. Over 200 articles published in Chinese English-language newspapers in 2015 were analyzed, using a combination of Content Configuration Analysis and Multidimensional Scaling (MDS) within a Hermeneutic Content Analysis framework. Our results indicate that corporations are merely perceived as a positive force, i.e., as actors who, often in partnership with other actors, are involved in tackling social and environmental problems and making significant contributions to social and economic development. The analysis reveals the systematic interrelations between different actions as well as between actions and economic, social, and environmental outcomes. For Africa, we find that Chinese involvement is characterized by a strong emphasis on the integration of economic and social development in that social achievements are tied to the economic development of the continent and the business operations, products, services, and area of specialization of Chinese corporations.

16 Sustainable Mobility: Access of Metrorail Commuters in the Western Cape

Zinette Bergman[1], Manfred Max Bergman[2]

[1] University of the Witwatersrand
[2] University of Basel

Public transport in general, and trains in particular, are often touted as the solutions to our mobility problems due to their reduced carbon footprint, high commuter-load, increased safety, and contribution toward reducing road congestion. However, how does sustainable mobility apply to contexts characterized by inequality, poverty, and exclusion, where train systems are poorly developed and maintained? In this study, we analyse the perspectives and imaginaries of train travel of Metrorail users in the Western Cape of South Africa, drawing from the literature on *Motility*. Based on 30 interviews with Metrorail users, we explore how they experience access to mobility. We outline various and interrelated service, infrastructure, and human-related challenges associated with accessing mobility options. Finally, we explore how perspectives and imaginaries on mobility options in general, and trains in particular, connect to notions of sustainable mobility.

17 Strategies Used by Activists in Israeli Environmental Campaigns: Policy and Practice Implications

Edith Blit-Cohen, Ariella Cwikel

Hebrew University, Israel

Current statutory planning laws in Israel allow a reality in which environmental surveys are commissioned by precisely those players who hold significant financial interests in their outcomes. This creates difficulties in obtaining an objective and unbiased professional opinion, necessary for evaluating actual environmental, social and public health costs of development projects. Furthermore, archaic plans are not required to be reevaluated in light of current spatial circumstances. The outcome of this situation makes it nearly impossible for communities to confront powerful forces, pushing for projects that threaten or endanger public health and the natural environment. This situation leads to local environmental conflicts, which have become increasingly common in Israel, as development pressures impinge on public health and well-being, environmental equity and habitat protection. This study examined the organizing and action strategies used in local communities within a framework of environmental campaigns, while identifying challenges, successes, the contribution of professionals and policy lacunae.

Method: Using a qualitative research design, which employed observations, interviews, protest case material and media analysis, a semi-structured interview was conducted with a sample including 11 activists from three different environmental campaigns in Israel's geographic and/or social periphery. The campaigns focused on different issues: 1) obtaining access to urban nature; 2) preservation of a unique natural habitat; and 3) opposing construction of a phosphate mine near a city.

Results: Strategies used include social action, confrontation, mobilization, and coalitions. Tactics included media and social media action, re-framing, stalling and abiding ethical codes. Tactics of disruption were seldom used. Success was attained when political climates changed and power structures were altered. Substantial challenges for local communities derive from inequality in power, resources, and access to decision-makers, compared to

their opponents; the length and complexity of campaigns; geo-social status of communities; and high personal costs for activists.

Conclusions: Results suggest that asymmetrical power relations call for expanding the repertoire of tactics to increase chances of success. Moreover, this study calls for a change in policy that will correct this distorted situation, and suggests several approaches: 1) Creating a national trust that will be allocated for commissioning independent environmental surveys; 2) Creating a grading system for assessing the financial worth of natural capital, that may help put natural habitat and public health concerns on a measurable scale, compared to financial and developmental interests; 3) Implementing changes in the current planning laws so that the public interest be heard.

Finally, local and national policies for approving statutory planning must take power structures and the work required to balance them into consideration, while environmental non-governmental organizations (NGOs) and agencies should support local communities mobilizing for change.

18 Mining as a Catalyst for Sustainable Development

Dee Bradshaw

University of Cape Town

Minerals and metals fundamentally underpin the functioning of every aspect of modern society. From electricity generation to the provision of the tools of connectivity; from the agricultural and manufacturing industry to the health industry and toothpaste ingredients. The dependency increases as the world embarks on the fourth industrial revolution and the need for a circular economy is recognised. However, society's negative perception of mining activities is also increasing with its contribution to increased inequalities, community confrontation and conflict as well as environmental degradation receiving widespread attention.

Thus, in spite of its relatively small size as an industry, the mining and extractives sector has the extraordinary potential to support the achievement of or impede or compromise the Global Sustainable Development Goals (SDGs).

Since mining is a global industry and is often located in remote, ecologically sensitive and less-developed areas, it has the unique potential to catalyse the sustainable development of the region by delivering on Goal 9: 'Build resilient infrastructure, promote sustainable industrialization and foster innovation'

This goal addresses the role of investments in infrastructure—transport, irrigation, energy and information and communication technology—which are crucial to achieving sustainable development and empowering communities in many countries. It has long been recognized that growth in productivity and incomes, and improvements in health and education outcomes require investment in infrastructure.

If carefully managed, inclusive and sustainable industrial development can provide the suitable environment to promote income generation activities and allow for the development of sustained livelihoods and stable communities.

19 Integrated Water Management for Mining Operations and Local Communities: South African Case Studies

Jennifer Broadhurst

Minerals to Metals and Future Water, University of Cape Town

Access to water for the extraction, transport and processing of minerals is crucial to all mining operations. Although typically only accounting for 2% to 6% of national water consumption, these operations can impose long-term, and sometimes permanent, impacts on the availability and quality of local water resources. This, in turn, can undermine the quality of life and traditional livelihoods of surrounding communities that depend on local water resources for domestic use, agriculture and livestock farming. It is thus hardly surprising that water has historically been at the centre of many mine-community conflicts, particularly in cases where operations have occurred in water scarce, environmentally or culturally sensitive areas.

Today, most mining companies recognise that responsible use and sound custodianship of water is a critical business issue, with site water management plans typically emphasising water re-use and recycling, as well as the use of non-potable or secondary water sources as far as possible. Many companies are also recognising the benefits of going beyond merely managing impacts and using site water more efficiently. By adopting a more collaborative and participative approach, mining operations have the potential to make a significant contribution to the provision of clean and adequate water on a regional scale. This can lead to establishing trust and enhancing company reputation, ultimately reducing the risk of conflict and improving water security. In this way, a scenario of “shared value” is created, that mutually benefits both the industry and the communities in which it operates.

This paper presents case studies of partnerships between South African mining operations and local government in the development of integrated water resource management (IWRM) plans to sustain both mining operations and the surrounding communities.

20 Travel Demand Analysis for an Innovative Car Sharing Electric Vehicle System

Stefano Carrese, Tommaso Giacchetti, Marialisa Nigro, Sergio Maria Patella

Roma Tre University

This paper focuses on the introduction of an innovative Car sharing Electric Vehicle (CEV) system in Rome, Italy. Specifically, this system was developed thanks to a recent agreement (April 2016) between the two partners involved: ENEL ENERGIA SpA, the largest electricity company in Italy, and Roma Tre University.
The whole fleet, 30 electric vehicles produced by Renault, has electric traction and the totality of users of the service is made up of students and employees of the University. From the infrastructural standpoint, 28 recharge stations were installed. Four hubs have been placed in four University departments (Engineering, Economics, Law, and Literature), and each of these hubs has seven recharge stations. Outside the University, ENEL has about 110 recharge stations spread throughout the city of Rome, fifteen of which are located both at the intermodal nodes and at special attraction points in the city.
The electric charging network is designed with a radial structure. The hubs are the departments that are close to each other and the spokes are the recharging stations. This structure is coherent with the university's request for a backward and forward star design.. The service has been planned as a “one way” car sharing: users can start and finish their journey at any of the charging stations of the project using a dedicated IT platform. The user interface is a smartphone app that is free to download.
The paper starts with the initial stages of the project where an ex-ante collection of data and information was conducted, adopting both **RP** and **SP** surveys. Results of the surveys involved a sample of about 1,200 potential users, and obtained important indications on the behavioural attributes that will affect the electric light vehicle sharing system subscription and its utilization. Afterwards, in mid-September 2016, the pilot test of the CEV service started: about 100 users that participated in providing results for the ex-ante survey have been involved in using the service for free. Data that is under collection will permit the evaluation of the impact of the new service on mobility habits and behaviours.

21 Relating Sustainability to Regulations Overseeing Food Products

Terence Centner

The University of Gerogia, USA

Consumer demands are expanding the choices of food products in the marketplace. Discerning consumers seek products that they feel are more healthy, such as antibiotic-free meat products. Some prefer products that are free from artificial ingredients, feed additive residues, and genetically modified organisms. Environmentally conscious consumers may seek organic and locally-grown products. Others are concerned about the humane treatment of animals. Preferences for products with selected attributes are leading food marketing firms to identify characteristics about their products through labels and other information. Given the value of products with specialized attributes, consumers need protection from fraudulently labeled products. In many cases, scientific testing cannot verify the truthfulness of attribute claims. Some type of oversight of the production process is needed to provide assurances that food products have the attributes being touted.

Governments and private firms have developed reliable certification systems and regulatory controls to oversee the veracity of differentiated products. Yet several questions arise regarding whether these efforts provide sufficient attention to sustainable practices. How does each of the various attributes relate to sustainability? Can greater attention be given to methods or procedures that would encourage or enhance sustainable agricultural production? Can greater efforts be taken to relate the production of differentiated food products in developing countries to sustainability?

This paper looks at several categories of differentiated food products to relate them to sustainability. Consumer reliance on numerous private certification programs overseeing production attributes does not negate the need for governmental efforts to enhance sustainability. By looking at product differentiation efforts, some types of governmental oversight may be identified to help firms structure activities that are more supportive of sustainability efforts.

22 Exploring the Role of Institutional and Policy Framework in Water Resource Monitoring and Management in a Sub-Saharan African Context: A Study of the Gauteng Province, South Africa

Simphiwe Chabalala, Danny Simatele

University of the Witwatersrand

Water resource monitoring and management are important aspects that contribute to ensuring safe water for drinking, recreational, agriculture, and other national development and economic processes. It has actually been argued that water is the basis of life and all forms of development. Despite the importance of water, many countries in sub-Saharan Africa, particularly in South Africa, are not effectively and adequately monitoring the quantity and quality of its water resources. Part of the reason for this state of affairs has been the absence of clearly defined roles, policies, strategies, and responsibilities, and a combination of these factors have resulted in significant fragmentations in the institutional structures mandated to manage water resources. Using field-based data collected through different research methods, this paper discusses the factors that contribute to the non-existence of an effective and unified water resource monitoring framework in South Africa, using Gauteng Province as a case study. The paper identifies and engages with a number of institutional challenges that contribute to impeding the formation and/or functioning of the water resource monitoring framework in South Africa. It is argued in the paper that until these challenges are addressed through the development of comprehensive institutional water resource management strategies, sustainable water resource management will remain a major challenge and will affect all subsectors of the economy. It is thus important that appropriate institutional and policy interventions are identified in order for the country to make a smooth transition in developing water resource monitoring and management tools through which effective water resource management can be pursued and contribute to sustainable development.

23 Mining as a Catalyst for Sustainable Development: Sustainability as a Source of Innovation

Brian Chicksen, Dee Bradshaw

University of Cape Town

The mining industry is not typically regarded as innovative. Mining practices and processes, particularly in deep level mines over the last century have improved gradually, rather than in a disruptive fashion. This is most evident in deep level mines operating in South Africa. This paper argues that the lack of innovation is largely driven by the way the industry sees competition. During upswings of the commodity cycle, the basis for competition is company size and the amount of raw product extracted. Resource companies thus focus on growth and footprint expansion. Growth is seen through a product lens—primary product (e.g., gold), by-products (e.g., silver) and related products (e.g., precious metals). In the current low price environment—in a price taking industry—the focus is on efficiency and productivity gains to manage profitability margins. The drive therefore is one of reliability, with the intent to reduce variability, have stable processes and do what we are currently doing better. This mindset may be further embedded by short-termism and analyst expectations. Through a sustainability lens, we see that the world has changed, with an emerging dialogue on the role of the corporation as an institution of society; an institution which must have a core purpose of positively contributing to the shaping and evolution of society within the complex spaces of economic and social development and environmental protection. In this context, the basis of competition has changed. The successful resources company of the future will be competing on the basis of: • Access to and cost of capital—from an increasing pool of socially and environmentally conscious investors and lenders who use sustainability performance as a component of the investment decision; • Access to prospective territory and the ability to realise value from it in the face of a growing and more powerful community and societal voice—realisation of a Social Licence to Operate; and • Access to talent with new generations being far more socially aware and unwilling to be part of an industry or company perceived to be destructive to people and the planet. Sustainability beyond compliance thus becomes a true

source of competitive advantage—and if realised, a source of innovation. Through a sustainability lens, we see opportunities for value creation based on competences rather than based on a generic product. Deriving value from competences such as land, water and energy management for mutual benefit introduces disruptive thinking to the industry and drives innovative practices. The trajectory envisaged is moving from the current transactional space characterised by low trust between stakeholders and constrained solutions, to a more transformational space characterised by high trust between stakeholders and creative solution. In this transformational space, we consider the greater good, co-design solutions with stakeholders and drive innovation. The most fundamental disruption would be changing the business model to one which creates multiple streams of value and turns liabilities into assets. In this way, sustainability shifts the way in which the business sees itself and the way in which it interfaces with the world.

24 Coastal Disaster Risk Assessment and Sustainable Development under Climate Change in Taiwan

Lien Kwei Chien, Ching-Chieh Hsieh, Wei-Po Huang

Department of Harbor and River Engineering, National Taiwan Ocean University

Due to the loss of coastal land by intensified global climate change, the threat to lives and property has become worse. The study integrated various levels of vulnerability and risk management of a coastal zone under the climate change assessment. Based on the Coastal Zone Management Act in Taiwan, in this study, the four hazard factors, namely sea level rising, subsidence, storm surge flooding, and coastal erosion, are discussed. Furthermore, the hazard index and the designating principles for coastal protection spatial zoning were established, and a first or second type of coastal protection spatial zone could be designated. On the other hand, the vulnerability factors are included as substance factors, natural environment factors, social-economic factors, and restoring factors in consideration of urban development. In order to obtain a hazard map and vulnerability map which are suitable for the coast of Taiwan, the Pareto Ranking method was applied to remove the weight of factor and to establish a comprehensive assessment of the index rating respectively. Then, the hazard and vulnerability indexes were combined to analyze the disaster risk in the coastal area and to display the risk map with geographic information systems (GIS). From the analysis of Pareto Ranking, the results show the distribution of coastal land with high hazard. Most high-hazard areas are located at southwestern and northwestern coastal areas in Taiwan. In addition, the result of the risk analysis in southwestern Taiwan also shows a similar tendency. It could provide the guidelines for coastal protection, spatial designation and the suggestion of sustainable development and management of coastal areas.

25 A Longitudinal Study of the Impact of Corporate Social Responsibility on Firm Performance in SMEs in Zambia

Progress Choongo[1], Enno Masurel[1], Elco van Burg[1], John Lungu[2]

[1] Department of Management and Organization, Faculty of Economics and Business Administration, VU University Amsterdam, De Boelelaan 1105, 1081 HV Amsterdam, The Netherlands
[2] School of Graduate Studies, The Copperbelt University, Kitwe, Zambia. P.O. Box 21692, Kitwe, Zambia

The aim of this study is to investigate the impact of corporate social responsibility on firm performance using a longitudinal design in SMEs in a developing country, Zambia. Data was collected from 153 entrepreneurs in two surveys and changes in CSR and firm performance measures were analysed over a 12-month period. The results of the cross-sectional analysis show that there is partial effect of CSR on financial performance, corporate reputation and employee commitment. The analysis of the longitudinal data, however, reveals that a positive and significant full effect exists between changes in CSR and changes in employee commitment. The association between CSR and financial performance, as well as corporate reputation, remains partially significant over time. These results are helpful to entrepreneurs, researchers and policy makers in understanding the outcomes of sustainability practices in SMEs in developing countries, especially in Sub-Saharan Africa.

26 The Pursuit of Subjective Well-Being and Conscientious Decision Making in the South African White Goods Industry

Lorna Christie[1], Nadine Cynthia Sonnenberg[2]

[1] UNISA
[2] University of Pretoria

Current global trends indicate that the population's consumption practices already exceed the Earth's bio-capacity by 50%. In this regard, the question remains whether consumption should be encouraged, especially in emerging economies, such as that of South Africa where economic growth is much needed. Though much debate shrouds current insight, experts suggest that consideration needs to be given to subjective well-being (encompassing economic, environmental and social dimensions) to ensure the sustainability of natural resources that will support consumption on a national level, satisfy human needs on a personal level and maintain the integrity of natural reserves for future generations. Since consumption of products has a direct and indirect impact on individual well-being and the larger population, consumers also have a responsibility to improve choices that may ultimately contribute toward reducing prevailing imbalances. Particular concern relates to more affluent consumer segments with increased spending power and a potentially higher contribution to the nation's ecological footprint. These consumer segments must be encouraged to make conscientious decisions that may elicit economic, environmental and social responsibility as a measurement of well-being instead of maintaining the prevailing hedonic treadmill. White goods serve as a typical example of products that require more conscientious deliberation. These products are deemed objects of affluenza, but simultaneously bear long-term economic and environmental implications due to their required energy and water consumption. Based on the aforementioned arguments, this paper presents empirical evidence to elucidate the complex interplay of consumers' pursuit of subjective well-being amidst symptoms of relative deprivation and affluenza that impact on consumers' willingness to engage in conscientious consumer decision making in the South African white goods industry.

27 What Is the Role of Consumers in the Transition Towards Low Carbon Living?

Anna Claudelin, Maija Leino, Suvi Konsti-Laakso, Ville Uusitalo

Lappeenranta University of Technology

Energy efficiency improvements and production of renewable energy possess significant potential to reduce greenhouse gas emissions of housing. The engagement of private consumers is highly important in the process of achieving low carbon living. Previous research has concentrated on technological solutions but only few studies consider the role of consumers in the transformation towards low carbon living. In this research, we focused on the willingness of detached house owners to adopt energy efficiency solutions and own renewable energy production systems. Also, the attitudes towards energy saving measures and energy production were determined. The research was carried out as a survey in two residential areas in Finland, and the potential greenhouse gas emission reductions were estimated using a life cycle assessment based on the survey results.

The most common renewable energy and energy efficiency solutions already implemented in the area are heat pumps and fireplaces. Heat pumps, solar electricity and solar heat are the solutions considered the most interesting options to be obtained by the consumers. Some solutions, such as solar heat, are not yet well-known. The greatest identified drivers of transformation are the better understanding of the possible annual savings attained and the costs of implementing these energy efficiency and renewable energy production solutions. Another identified driver is the better understanding of the technologies related to renewable energy production. The research also indicates that whilst people believe they act environmentally friendly, they could actually achieve greater energy savings by small adjustments to their habits. The greenhouse gas emission reductions in the residential areas surveyed would be approximately 18 percent if the consumers applied the options they considered. Based on this research, it can be concluded that consumer selections play a significant role in a transition towards low carbon living. In addition, more attention should be paid to consumer needs for solving bottlenecks in the transition.

28 Sustainability in a Megadiverse Country: Agroforestry Contribution to Biological and Cultural Conservation in Colombia

Gabriel J. Colorado Z.

Universidad Nacional de Colombia

Colombia is commonly known as one of the most biologically and culturally diverse countries in the world. Unfortunately, this is coupled with one of the highest deforestation rates and habitat loss among Neotropical countries. The major drivers of deforestation in this country include agricultural intensification, increasing resource usage by cities, and logging. In particular, several methods of production that traditionally enhance biodiversity conservation by the use of shading (i.e. Agroforestry), are being rapidly transformed into low-quality systems, which show several pervasive negative consequences associated with the homogenization of ecological systems. This is reinforced by an ineffective transmission of ecological knowledge. Due to this worrisome scenario of current and projected rates of habitat degradation, the reexamination of traditional agroforestry systems represents an invaluable opportunity to link highly modified landscapes with biodiversity conservation and socio-cultural development. In this presentation, I discuss the ecological, social, and economic benefits of these practices and their relative contribution to the environmental sustainability of Colombia. In particular, I examine the role of agroforestry systems in providing sustainability by supporting biodiversity and land productivity which, in turn, enhance the well-being of human communities. Moreover, positive feedback is found in most agroforestry practices (e.g. restoration of degraded areas), highlighting additional benefits which should be considered under climate change scenarios. The significance of reincorporating agroforestry systems into land productivity and management, and in general, sustainable agroecosystems practices in Colombia for long-term environmental conservation, is discussed under the available information.

29 An Holistic Approach to Mobility Transitions

Tim Cresswell

Trinity College, Hartford, CT, USA

This paper considers the conceptualization of transitions to low and non-carbon mobilities. The ways that we move are the second largest contributor to greenhouse gas production. They are also the largest user of oil. In a world of anthropogenic global warming and post-peak oil it is important to consider ways to move in more sustainable ways. Existing theories of tranistion emphasize “socio-technical” regimes as arenas for change. Despite its evolving nature this theoretical approach still places technology at its center. In this paper I will draw on a large scale research project comparing transition policies across 14 countries to suggest the outline of an approach to tranisition built on mobility theory that emphasizes movement, meaning and practice as interlinked arenas of transition. Technology is only one aspect of this.

30 Using Urban Metabolism as a Guiding Concept for Sustainable Infrastructure Planning in Cape Town

Paul Currie, Megan Davies

Stellenbosch University

Assisting cities with the transition to, or construction of, efficient, equitable and appropriate infrastructure systems has been identified as a key imperative for improving global sustainability and reducing poverty. Such an endeavor faces multiple challenges, namely (i) incomplete or uncertain visions for sustainable cities, (ii) entrenched socio-technical infrastructures and behaviours, (iii) data scarcity, which limits scientific or data-driven planning (i) disconnected forms of urban governance that hinder integrated planning, and (v) land-use- or supply-driven planning regimes, which overlook resource and service demands. Addressing each of these concerns requires a unifying concept within which to operationalise *the city* and make identify potential interventions for socio-technical transitions. This is identified as *urban metabolism*, which is the emergence of the processes by which cities gain, process and dispose of resources. It isis intimately related to the current and future needs of the city's inhabitants and can thus be used as a tool to provide useful indicators about a city's social, environmental and economic sustainability, as well as to identify points of intervention. At present there is no globally standardised mechanism for assessing or quantifying the urban metabolism of a city, particularly when examining cities of the global South, in which informality and data scarcity are a common reality.

Following Newell and Cousins' (2015) notion of urban metabolism as a *boundary metaphor* between parallel discourses, this paper argues that it is necessary to draw together the discourses of industrial ecology (resource flows), urban ecology (socio-economic systems) and political economy (unequal access to services). In order to do so, the paper links urban metabolism with the urban governance literature (Smith et al. 2005, Guy et al. 2011) and in order to present a framework to aid sustainable urban planning. Finally, the City of Cape Town is used as a case study to show how such a framework would prove beneficial to the city's infrastructure development.

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31 Review on the Analysis of Trace Metals in the Unsaturated Zone of Cemetery Soils

Francisco Carlos da Silva, Paulo Sergio Tonello, Valquíria de Campos

UNESP - Câmpus de Sorocaba

This study conducted a literature review on the presence of trace metals in the unsaturated zone in cemetery soils. Most existing cemeteries were installed without thinking about the potential risks to the local environment or community. Toxic chemicals can be released into groundwater; these products include substances that were used in the embalming and varnishes, sealers preservatives, and metals in the handles of coffins, and props used in wooden coffins. Studies published in the last 30 years concerning these chemicals were included in the review. The results suggest the need to monitor pollution in order to ensure that water sources around cemeteries are not in danger due to the release of toxic heavy metals such as human remains and other decaying materials. It was concluded that higher levels of trace metalsin cemeteries are influenced by the nature of the burials, types of materials used, and the local geology.

32 Experimentation, Governance and Sustainability Transitions in the REIPPPP: A Transdisciplinary Case Study of the ZF Mgcawa Development Coordination Forum

Megan Davies, Mark Swilling

Stellenbosch University

The South African Department of Energy (DoE) launched the Renewable Energy Independent Power Producers Procurement Program (REIPPPP) in 2011 to secure additional renewable energy generation capacity for South Africa's national electricity grid. This was accompanied by stipulations in the policy framework regulated by the Independent Power Producer Unit (IPPU) that integrated expenditure targets in an effort to drive socio-economic (SED) and enterprise development (ED) in designated beneficiary communities, together with requirements related to community ownership. Due to the considerable uptake within the REIPPPP and the multiplication and density of IPPs in specific areas, challenges have been highlighted with regards to the fulfilment of SED and ED targets. Employing van Breda and Swilling's (2016) concept of 'emergent transdisciplinary design', initial transdisciplinary research engagements, with, amongst others, the IPPU, development finance institutions, industry groups, municipalities and beneficiary communities in the Northern and Easter Cape, have illuminated three broad challenges in the REIPPPP; namely, *procurement and implementation*, *reporting, monitoring and evaluation* and finally, *governance and coordination*.

This paper unpacks challenges pertaining to governance in the REIPPPP , demonstrating a case study of the ZF Mgcawa Development Coordinating Forum (DCF) that links the literature on experimentation and the governance of sociotechnical transitions towards sustainability (Smith, Stirling and Berkhout, 2005; Broto and Bulkeley, 2014; Evans, Karvonen and Raven, 2016; Swilling and Hajer, 2016) with a grounded investigation of this novel collaborative initiative. The forum, comprising local authorities, IPPs, civil society and private sector players in the District Municipality surrounding Upington is an initiative aimed at supporting more effective interaction, alignment and collaboration regarding their respective development mandates.

Whilst the REIPPPP is internationally acclaimed as a progressive framework connecting the 'green' and 'brown' developmental agendas within South Africa's energy landscape, it is necessary to interrogate the potential for this emerging 'socio-political regime' (Swilling, Musango and Wakeford, 2015) to support a 'just transition' towards sustainability. An exploration of the ZF Mgcawa DCF serves as a transdisciplinary case study that demonstrates how experimental governance might support the consolidation of this 'socio-political regime'.

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33 The Great African Cook-Off – Exploring User Preferences for Improved Cook Stoves (ICS) Through Participatory Multi-Criteria Analysis

Jiska De Groot[1], Charlotte Ray[2]

[1] Energy Research Centre, University of Cape Town
[2] University of Nottingham

In line with **SDG** goal 7's aim to "ensure access to affordable, reliable, sustainable and modern energy for all," 2014–2024 has been hailed as the "decade of Sustainable Energy for All" (SE4All). However, 2.7 billion people globally still rely on solid biomass fuels to meet their cooking and heating needs. In Sub-Saharan Africa, this equals around 80% of the population. This has significant impacts for sustainable development, as traditional stoves are associated with a range of environmental, social, human health, and economic impacts. Improved cook stoves (ICS)—designed to burn biomass fuels more cleanly and efficiently—have been promoted by charities, governments, and private sector actors in developing countries since the 1950s. Despite a plethora of interventions, adoption rates and sustained use of improved cookstoves remains low globally. Given that many interventions promoting 'improved' cookstoves adopt a quantitative, techno-centric approach, they frequently fail to address end-users' views and priorities. Recent studies, however, have seen the benefits of adopting qualitative, participatory methods to explore the non-technical dimensions of ICS dissemination incorporating socio-cultural dimensions.
This paper presents the results from the Great African Cook-Off, hosted in Zambia in 2016. The event aimed to stimulate dialogue around user preferences and opinions of improved cookstoves and functioned as a platform for testing a participatory methodology for eliciting user preferences based on a multi-criteria assessment. The study found large differences in stove performance based on user preferences and experience. The methodology was found to stimulate discussion amongst participants and the audience of the event, achieving the joint objective of exploring user preferences for ICS in a local context and creating a dialogue around ICS with the wider public.

34 Reporting on Long-Term Value Creation: A Longitudinal Analysis of Canadian Public Energy and Mining Companies

Petra Dilling

New York Institute of Technology

While stakeholder expectations with regard to corporate social responsibility (CSR) for large companies have been increasing over time, sustainability reporting has become a very popular topic within the last few years. At the same time, expectations have also been increasing regarding information on the long-term perspective of an organization. It appears that companies increasingly disclose information about their long-term plans and performance. In support of this perception, researchers have argued that companies are progressively providing more information on company strategy, long-term value creation, and the linkage between financial and non-financial information in their annual reports.

This paper is the first to extensively analyze the development of disclosure practices of twenty Canadian public mining and energy companies by looking at their annual financial as well as sustainability reports for the fiscal years 2012 and 2014. The analysis includes all important aspects of long value creation, such as disclosure of long-term perspective, information on the linkage between business and sustainability strategy, energy costs, innovation emphasis, risk management, climate risk exposure, governance structure, responsible workplace practices, indirect economic impacts, relationships and collaborations with outside stakeholders, non-compliance with laws and regulations, etc. Although the variables that have been used are based on the Integrated Reporting <IR> framework, additional disclosure items according to the Global Reporting Initiative (GRI) G4 guidelines have also been included.

The empirical research findings suggest that overall disclosure quality on long-term value creation reporting has increased over the examined timeframe. This is particularly true for some reporting areas, such as stakeholder engagement and long-term perspective of the company. However, substantial gaps, especially in certain other reporting areas, for instance, with regard to the financial impact of variables on the overall long-term performances of the companies could also be identified.

35 A Spatial Analysis of Effectiveness of Eradication of Invasive Species in Improving Grazing for Marginal Livestock Economies in Dryland of Matabeleland South Region, Zimbabwe: A Focus on *Lantana camara* and *Opuntia fulgida*

Oliver Dube, Joy-Noeleen Ndlovu, Ntandoyenkosi A Ncube

Department of Environmental Science and Health, Faculty of Applied Sciences, National University of Science and Technology, Bulawayo, Zimbabwe

Invasive alien plant species proliferation, which is partly accelerated by land disturbance associated with recurrent droughts in marginal areas, is viewed as a major threat to sustainable development. The invasive species of concern in this study are *Lantana camara* and *Opuntia fulgida* with occurrence frequency of 43.8 % and 33.8% respectively in the dryland areas of Matabeleland South region, Zimbabwe. The study focused on the effects of eradication of the invasive species and this was conducted in ward 14 and Ward 16, Gwanda and Bulilima Districts, respectively. The eradication exercise was carried out by a community affected by common property resource management contentions. The first step involved mapping the distribution and extent of eradicated areas in the two sites. A survey was carried out on randomly selected respondents where an assessment of knowledge, attitude, practice, as well as economic losses due to proliferation and gains accorded by the eradication of invasive species, was determined. The study found that the actual reported loss of livestock in Bulilima resulting from *Lantana camara* poisoning was estimated at $9 900/year. However, eradication recovered grazing potential of 37.6 hectares, an average carrying capacity of seven heard of cattle with a conservative total market value of $3 500.00/yr. Over and above, the eradication initiatives significantly improved knowledge, attitude and practice of the community regarding effects of invasive species by a frequency score of around 80%. Nonetheless, this behavioral change was found to be strongly embedded in external monetary incentives with a frequency score of 88%, indicating an economic response to common property management. The study recommends an extensive use of the digging and pulling out or tree popping

method for the eradication of concerned invasive species; a structured and pragmatic use of incentives in mobilizing communities in reducing degradation of common property resources.

36 Developing Decision Support Tools for Improving Agricultural Sustainablity in Africa

Kevin Jan Duffy, Tirivashe Phillip Masere

Institute of Systems Science, Durban University of Technology

We are developing decision support tools for assisting small-scale farmers in eastern and southern parts of sub-Saharan Africa to increase their agricultural production. The overall aim is to improve sustainable food security in the region. The overwhelming message from our research is that generally in Africa poor soils, limited rainfall and intermittent rainfall are the major contributors to low crop productivity. A protocol for developing an integrated decision support tool has been developed. This tool uses historically derived climate and soil grid data to construct simulated historical crop yield data under different crop management options. These data are combined with rainfall predictions thus giving end users (small-scale farmers and extension officers) information on potential yields based on management decisions under a below normal, normal and above normal rainfall seasons.

37 Vulnerability of Maize Yields to Droughts in Uganda

Terence Epule Epule

Department of Geography, McGill University, 805 Sherbrooke St. W., Burnside Hall 416, Montreal, Quebec, Canada H3A 0B9

Climate projections in sub-Sahara Africa (SSA) forecast an increase in the intensity and frequency of droughts with implications for maize production. While studies have examined how maize might be affected at the continental level, there have been few national or sub-national studies of vulnerability. We develop a vulnerability index that combines sensitivity, exposure and adaptive capacity, and integrates agroecological, climatic, and socio-economic variables, to evaluate the national and spatial pattern of maize yield vulnerability to droughts in Uganda. The results show that maize yields in the north of Uganda are more vulnerable to droughts than in the south and nationally. Adaptive capacity is higher in the south of the country than in the north. Maize yields also record higher levels of sensitivity and exposure in the north of Uganda than in the south. Latitudinally, it is observed that maize yields in Uganda tend to record higher levels of vulnerability, exposure and sensitivity towards higher latitudes while in contrast, the adaptive capacity of maize yields is higher towards the lower latitudes. In addition to lower precipitation levels in the north of the country, these observations can also be explained by poor soil quality in most of the north and socio-economic proxies such as, higher poverty and lower literacy rates in the north of Uganda.

38 Vision Development towards a Sustainable North Rhine-Westphalia 2030 in Science-Practice-Dialogue. Approach, Results and Lessons Learnt from the Sustainable Strategy Formulation Process in the Federal State of NRW

Manfred Fischedick, Oscar Reutter, Miriam Müller, Mona Treude, Dorothea Schostok

Wuppertal Institute for Climate, Environment and Energy, Germany

Sustainable development is a cross-cutting task and requires coordinated actions and strategies at local, regional, national and supranational policy levels. Besides the United Nations 2030 Agenda for Sustainable Development[1], adopted in 2015, and the National Sustainability Strategy of Germany[2], adopted in 2002, eleven out of 16 German federal states have already adopted their own state-wide sustainability strategies[3]. States play a vital role in managing transitions towards sustainable development because of their proximity to regions and cities, citizens, civil society and companies[4]. The state government of NRW recently developed its sustainability strategy[5], which represents a state-wide approach to strategically manage the transition of NRW towards sustainable development.

Vision development and target formulation are important instruments at the strategic level of transition management[6] and are part of the good governance criteria for sustainable development[7]. Visions are “qualitative, inspiring, challenging and imaginative pictures of the future that define a structurally different, and more sustainable, state of the system”[8]. Their “over-arching goal is to stimulate a sense of shared direction and ambition amongst a variety of actors”[9]. Thus, as one work package, the project investigates the research question on what a vision “Sustainable NRW 2030” can look like if developed in a science-practice-dialogue.

For creating a shared vision “Sustainable NRW 2030”[10], the Wuppertal Institute developed a first draft text version. According to the “participatory nature of transition management” which “allows for iterative problem- and

goal formulating processes between different types of actors"[11], this draft version was discussed and further developed in dialogue with actors from civil society, science, administration and politics in several iterative loops. The vision was developed following several criteria:

- Normative orientation: "This is how we want to live!"
- Target year 2030 – with a perspective of 2050
- Generally valid and NRW-specific
- Interdisciplinary consensus in society and politics
- Ambitious and feasible, not utopian or naive
- Scientifically correct and comprehensible
- Holistic
- Creating images
- Incorporation of existing concrete targets and target propositions in footnotes

The vision developed describes a desirable picture of a sustainable NRW in 2030 in a narrative text and formulates quantitative targets and indicators in footnotes, for example a desirable modal share of 25% trips by car, 25% by public transport, 25% by bike and 25% by foot. The vision considers the specific challenges and contexts of NRW – for example the urban and industrial structures of NRW. As a result of the iterative loops in dialogue with stakeholders from science and practice, the contents and length of the vision changed in four different versions. New topics and aspects were added to the final version, for example energy poverty.

In the presentation, the vision of a "Sustainable NRW 2030" will be presented regarding its contents and the processes undergone for developing a common vision in a dialogic, iterative approach.

The paper presents the approach, results and lessons learnt from the vision development within the on-going scientific project "Sustainability Strategy for North Rhine-Westphalia (NRW) – Conceptual Analyses and Considerations on Designing a Sustainability Strategy NRW from the Science Perspective" (2013-2017). It accompanies the development of the sustainability strategy for the federal state of NRW, which is envisaged to be adopted in 2016. The paper presents the experience of this real world case of transformative science with regard to vision development. Project Website: http://wupperinst.org/en/p/wi/p/s/pd/469/

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39 Journey towards One Vision, One Plan, and One Value System: The Case of Hessequa Municipality

Elaine Fouche, Alan Brent

University of Stellenbosch

In order to manage today's complex problems and achieve sustainable development, a holistic approach that can deal with interconnectivity, uncertainty, and the perspectives of many stakeholders is required. This paper discusses the case of Hessequa, a local municipality in the Western Cape Province of South Africa, which aims to include renewable energy as part of its strategic plan. However, when delving into the details of this case, it becomes evident that municipalities in a developing country context first need to gain a mutual understanding of the system and its priorities in order to plan for implementation. Using Checkland's Soft System Methodology, the research to date shows that sustainable infrastructure is one of the priorities that needs to compete for funding and limited resources, among many other priorities, such as the development of sustainable education systems, social cohesion, sustainable economic growth, and environmental conservation. Further work is needed to develop and communicate a shared vision and to agree on a structured plan among the many stakeholders at the local governmental sphere, in order to facilitate a just transition from an energy perspective.

40 Green Building Culture and Energy Conservation in the Townships

Antonio Frattari[1], Williams kehinde Kupolati[2], Federico Berghi[1]

[1] University of Trento
[2] Tshwane University of Technology in Pretoria

During the past 50 years, twenty percent of the inhabitants of the planet have had a strong development that deeply impacted positively on their habits and quality of life. On the other hand, the remaining four-fifths of the inhabitants are living in bad condition because of a lack of meaningful opportunity. An emblematic case is the living quality in the townships. There is a need to enhance the quality of life in the townships in such a way as to be in balance with nature, avoiding continuing pollution to our planet. There is a vital need for a paradigm shift; rethinking the buildings, the cities and their organization to ensure the lifestyle that we have at present, and to have a sustainable city that grows and develops from a new, good relation between nature and mankind, in which it is possible to recreate the lost human contacts.
In order to realize sustainable buildings in balance with the natural environment and to reduce, to the minimum, the impact in terms of pollution and exploitation of the not renewable resources, it is necessary, in our opinion, to follow six design criteria in the building design:

1. Use of **renewable or recyclable and recycled materials** for the building construction;
2. Use of a **thermal insulation** coherent with the climate local conditions;
3. A strong **bioclimatic characterization** of the buildings;
4. Integration with energy systems that use **alternative and clean resources**;
5. Installation of **building automation systems** for managing the energy consumption;
6. Energy interchange between the buildings and the infrastructures: the **smart district**.

The question is to establish a viable transfer of these concepts of building sustainability to the real case of townships in terms of:

1. Enhancement of life quality;
2. Conservation of not renewable resources;
3. Reduction of the pollution of the environmental matrices: water, soil, air;
4. Reduction of energy consumption

For the attainment of these noble goals, firstly, we have to enhance the green culture of the people; then, develop new urban models; and lastly,

improve the buildings. The execution of the latter may involve refurbishment of the existing building estate and/or introduction of new buildings constructed with new criteria.

Several solutions to the above challenges have been identified through collaborative research conducted by Tshwane University of Technology, Pretoria, South Africa and University of Trento, Italy with the support of the Italian Institute of Culture, Pretoria, South Africa.

41 Reviving the Desakota Concept to Address Climate and Disaster Risks in Urbanizing Regions of India

Sumetee Gajjar

Lead - Practice, Indian Institute for Human Settlements, India

The term Desakota has been applied to explain the occurrence of intensively intermingled agricultural and urban forms of land use, in the context of South Asian cities. Such geographies are characterized by developed transportation networks, a mobile population, commodification of the local economy, governance in transition, greater technological penetration, and more female participation in the formal sector. At the same time, wetlands, natural drainage networks, and green cover, which can provide a substantive buffer against disaster events are increasingly 'constructed or paved over'. Vulnerability in these areas is made up of overlapping risks, exposure, and sensitivity to not only disasters (on a systems level), but also a lack of basic services, skewed livelihood options, and a reduced ability to negotiate access to ecosystem services (on a household level).

Recent urban flood events in India (in high altitude and semi-arid landscapes) as well as the loss of life and economic productivity in some of our coastal towns and cities elicits questions related to the resurrection of vulnerability as lower economic populations are moved from one risk prone site to another, in the name of development or resettlement. Some regions in India are more prone to experiencing environmental, climate related, and other disasters. Within these regions particular population groups, economic sectors, and locations are more vulnerable to the impacts of environmental disasters (including climate change) and other hazards. However, these peripheral areas continue to experience autonomous settlements by migrants, and greater capital investment towards real estate development, as well as secondary and tertiary economic sectors.

We find that the divided (urban and rural) policy landscape in India fails to address the particular challenges arising from transforming geographies, often small towns or villages, in close proximity of large cities. In the absence of an integrated climate action plan, articulated for multiple levels of cities and regions, the vulnerability of systems and households to environmental disasters remains unaddressed. Urban missions (AMRUT, SMART, Swachh

Bharat) focused on transformation are set to reform local governance and finance structures. These missions however, ignore environmental problems related to unregulated land use in the periphery of cities, and beyond. We recommend reviving the Desakota concept to understand and address environmental risks in rapidly transforming regions of India, which are no longer rural, but are not urban either.

42 Climate Change Predicted to Increase, Decrease, or Not Change Growth and Water Yield Depending on Mean Annual Temperature of Loblolly Pine Forests in Southeastern U.S.

Carlos Alberto Gonzalez-Benecke[1], Robert O Teskey[2], Timothy A Martin[3], Heather D Aldridge[4]

[1] Oregon State University
[2] University of Georgia
[3] University of Florida
[4] North Carolina State University

Using an updated version of the 3-PG model we predicted loblolly pine biomass production and water use under future climate scenarios across the range of the species's distribution. Using future climate data from 20 Multivariate Adaptive Constructed Analogs from 20 global climate models (GCM), the 3-PG model predicted an increase in growth and water use in the cooler part of the loblolly pine region and either no change or a slight decrease in growth and water use in the warmer part of the range under both RCP 4.5 and 8.5 scenarios for stands growing at mid-century or at the end of the century. The main reason for this was that precipitation was predicted to not change very much during the century, based on the mean of the 20 GCMs that were used to provide climate projections. This suggests that planted pine stands in this region will experience an increase in growth or will maintain current or near-current growth rates for the foreseeable future.

43 Digital Transformation of Non-Formal Education: Can MOOCs Support Under-represented Target Groups Such as Women in STEM?

Catrina Grella

Hasso Plattner Institute

Digital education is fundamental for co-creating current social and technological trends. In Massive Open Online Courses (MOOCs) several thousand learners can participate worldwide (HFD 2015: 6) and the integration of social media enables collaboration. MOOCs can revolutionize, democratize and individualize education (Ihsen 2015: 3).
In the context of opening education for under-represented target groups such as women in Science, Technology, Engineering and Mathematics (STEM) (Lorenz et al. 2015) we will answer the following research questions: Do MOOCs address underprivileged groups? How can digital education support these groups? Are there any ambivalences between the intended opening and a de facto closure, e.g., because of group-specific learning materials or stereotypical teachers (Martin 2013: 16)? How can we prevent or overcome a digital divide?
In the paper at hand, we analyze the participation in MOOCs in the field of computer science under consideration of the following dimensions of inequality: gender and educational as well as occupational background. This selection is based on theories of socialization and milieus (Hurrelmann 2006; Barz/Tippelt 2004). The data consists of more than 20 online courses at the educational platform “openHPI” https://open.hpi.de/?locale=en with more than 300,000 enrollments (HPI 2016).
The results show that MOOCs open universities in the meaning of lifelong learning: Currently, only 15 percent of learners are enrolled in university. On average they are 40 years old. On the contrary, MOOCs are closed in regard to gender (only 16 percent are female) and well-educated people (more than 80 percent finished at least college). We discuss the ambivalence between opening university and de facto closure in regard to interdependencies with the employment system. Furthermore we provide guidance for reducing unequal participation in MOOCs, e.g., via collaborative learning (Staubitz et al. 2014), target-group-specific design (HFD 2015: 8) and scouting of new participants (Bremer/Wagner/Kleemann-Göhring 2014: 9).

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44 Uptake of On-Farm Processing of Organic Waste

Anouschka Groeneveld[1, 2], Martha Bakker[1], Jack Peerlings[2], Wim Heijman[2]

[1] Wageningen University, Land Use Planning Group, the Netherlands
[2] Wageningen University, Agricultural Economics and Rural Policy Group, the Netherlands

Intensive agricultural practices resulted in higher yields and economic development, but also in soil organic matter decline, soil erosion, biodiversity loss and ground water contamination (D'Hose et al., 2014). Together with expected natural resource depletion, this leads to a need to make agriculture more sustainable. An example of sustainable farming practice is on-farm processing of organic waste. The goal of this paper is to show how this practice might spread within a region. We study three mechanisms that can lead to a gradually accelerating adoption of innovations, which can ultimately lead to a regime shift from unsustainable to sustainable practices. First, economies of scale can arise when there is the possibility of cost sharing among farmers (Agnolucci and McDowall, 2007). Second, farmers are more likely to adopt innovations after their effects are successfully demonstrated (Brown, et al., 2016). Third, incorporation of the practice in the social capital of a community and adjustment of the social norm may happen (Perman, et al., 2011). We developed a multicriteria mathematical programming model at individual farm level, for which we obtained an empirical basis using interviews with local farmers. We created an artificial farm population to represent the farmers in the region based on these initial farmers. Using the artificial farm population, we simulate the uptake of on-farm processing of organic waste. Our results show that random variations in yield and farm population can explain why, in some instances, a tipping point is reached resulting in a shift towards processing organic waste and not in others. When we consider the effects of the three mechanisms separately, it might seem that although processing organic waste on farm becomes more popular, it is unlikely to become a standard practice in the region. However, the interaction between the mechanisms will lead to a much higher uptake.

45 The Meat Naturally Sustainability Model: Linking Landscape and Livelihood Benefits Through Rangeland Stewardship and Entrepreneurship

Heidi-Jayne Hawkins[1], Nicky McLoed[2], Sissie Matela[2], Tennille Rhode[1], Gerbrand Nel[3], Halcyone Muller[4], Nompendulo Mgwali[3], Nolubabalo Kwayimani[3], Rosanne Stanway[1], Sinegugu Zukulu[3], Ronald Newman[4], Sarah Rose Frazee[1]

[1] Conservation South Africa, Heritage House, Suite 301, 3rd Floor, 20 Dreyer Street, Claremont, Cape Town, 7735
[2] Environmental and Rural Solutions, 110 Main Street, Matatiele, 4730
[3] Conservation South Africa, 112 Main Street, Matatiele, 4730
[4] Conservation South Africa, 89 Apie Visser Street, Springbok, 8250

Rangelands cover over 70% of South Africa and livestock farming activities yield five million tons of produce with a value of half a billion dollars per annum. However, unsustainable livestock farming practices and alien invasive plants have resulted in nearly 60% of these areas having a threatened ecosystem status. The Meat Naturally initiative in Northern and Eastern Cape of South Africa makes innovative use of government funding to secure water, food, income and climate resilience for the region. The Rangeland Toolkit (www.umzimvubu.org/toolkits/rangeland), produced by the Umzimvubu Catchment Partnership Programme, outlines methodologies to do this and is informed by ongoing research.
Over the last three years the initiative has resulted in the clearing of 2155 ha of invasive alien plants; 3564 m^3 of gabions in erosion gullies and 101 461 ha of improved rangeland management. At the same time, the government funding has been used to train and employ 'Ecorangers' in clearing, erosion repair, animal husbandry and traceability, grazing approaches, and wildlife-friendly predator management amounting to 25 921 person days. Our efficiency per hectare and person day are well above average compared to similar programmes. In addition, the initiative has gone beyond mere job creation by linking rural land owners to markets via mobile auctions, e.g. R2 400 800 has flowed into 8 villages in the Eastern Cape. But how do we become independent of external funding? As the next step, an entrepreneurial model called Meat Naturally Pty aims to link ecological infrastructure, climate resilience, healthy livestock and rural livelihoods by

formalizing market access (buyers and revenue flows). Besides this, the model includes skills development, incentives and the re-building of traditional social structures. A feasibility study indicates that the enterprise will become profitable within four years.

46 Resilience and Its Application in Corporate Sustainability

Lorren Haywood

CSIR, South Africa

It is no longer enough for business to simply be 'less unsustainable'. Due to the unprecedented pace of global change there is a need to firmly refocus business within the limits of the systems in which they operate. Sustainability is no longer just about reducing ones impact on the environment by being more resource efficient, it is rather an attribute of a dynamic, adaptive system that is able to flourish and grow in the face of uncertainty and constant change. Sustainability is linked to the functionality and structure of social ecological systems and thus there is much focus on the concept of resilience and its application towards facilitating sustainability. Resilience elevates sustainability towards addressing the adaptive capacity of the business in the light of global change. Resilience provides the practical mechanism through which to achieve the goal of sustainability; as it is about existing and continuously adapting within the social and ecological boundaries and thresholds of a defined system such that the system is able to maintain a favourable function and structure. Resilience thinking thereby shifts the concept of sustainability from that of maintaining stability and controlling change to rather dealing with changes, disturbances and uncertainties such that systems have sufficient social and ecological variables to support the capacity of the system to be adaptive during periods of change. We suggest that business need to transform their sustainability practices and initiatives to be closely aligned with key concepts from systems dynamics to enable organisations to understand the effect of their actions on the whole system upon which their business operations depend. We have defined seven principles that will facilitate business to build resilience into their management, strategies and reporting. The value return being the adaptive capacity to remain resilient to continue to create business and societal value.

47 The Challenges of Organic Farming in Arid Regions

Rhonda R. Janke[1], Tamam Khawalda[2], Rasha Istaiteye[3]

[1] Crop Sciences Department, College of Agriculture and Marine Sciences, Sultan Qaboos University, Muscat, Oman
[2] Head of Organic Division, Ministry of Agriculture, Amman, Jordan
[3] Assistant Professor, Faculty of Economics and Administrative Sciences, The Hashemite University, Jordan

Organic farming has many proven benefits in most parts of the world where it has been implemented, such as improved soil quality; more efficient water and nutrient cycling; and economic benefits to farmers in the form of higher prices, and social networking with other farmers and consumers. However, in arid countries, such as Jordan and Oman, certified organic farming has yet to thrive. Using these two countries as case studies, we find that both only began certifying farms in 2008 using non-local certification organizations and global standards. In Jordan, with the initial help of external funding, 98 farms on 2898 ha were certified in 2012, but by 2015 this number has declined to only 19 farms on 1706 ha, a 5-fold decline in only 3 years. Average farm size of the certified organic farms increased 3-fold, and the majority of certified farms are large, olive-oil producers with an export market. In Oman, only five farms on 39 ha are currently certified, and this number has not changed since 2012. Challenges to organic farming, and possible solutions will be addressed in this presentation, including; 1) current lack of local organic market demand, with the result that only the export markets bring price premiums, 2) fresh water sources are limited, but re-cycled waste water is available to agriculture, but currently not allowed, in accordance with international organic standards, 3) organic certification is expensive, and the cost does not make economic sense, except for large, well-financed farms, 4) much local traditional agriculture is “almost organic,” but is not recognized or labeled in the market-place, and 5) without a critical mass of local organic growers, supplies like organic seeds, biological pest control products and animals feeds must be imported and are expensive and not sustainable.

48 The Redesign of Sustainable Agricultural Crop Ecosystems by Increasing Natural Ecosystem Services Provided by Insects

Astrid Jankielsohn

ARC-Small Grain Institute

Agriculture is the cornerstone of the South African economy and farmers must ensure that they produce enough to keep up with the needs of our growing population, within the limits of nature's increasingly constrained and over-used resources. South Africa is a semi-arid, water-scarce country with a high degree of natural variability in its weather systems and with extreme events such as droughts and flooding. With climate change, these extreme events will only increase. The only way that we will meet all these challenges successfully is to change our food production systems to more sustainable systems.Natural ecosystems are resilient and able to survive extreme climatic changes because of the diversity in these systems. Conventional agriculture has decreased biodiversity on many different levels including plant genetic resources, insects, and soil organisms. Practices that conserve, sustainably use, and enhance biodiversity at all levels in farming systems will maintain healthy ecosystems and ensure food security. Well characterized relationships between biodiversity and ecosystem function are key to predicting the ecological and economic impacts of human activities. In terrestrial ecosystems, insects play key ecological roles and provide ecosystem services in diverse ecological processes such as nutrient cycling, seed dispersal, bioturbation, pollination, and pest control.
Agrobiodiversity should be considered as the basis for redesigning sustainable agroecosystems by mimicking natural ecosystems, but a deeper understanding of these mechanisms driving the relationships between crop diversity, beneficial insects, and pests or diseases is needed in order to make cropping system diversification an effective and reliable tool. In order to redesign an ecosystem, we therefore first need to know the different components, their functions in the particular ecosystem, and the interaction between these components that is needed to benefit the ecosystem as a whole. We can then use this knowledge to create models for agricultural crop ecosystems that will be resilient enough to survive the challenges of a constantly changing environment.

49 Morality and Climate Change: Detailing the Communication Challenges Based on Survey Data

Johan Jansson

LUSEM, Lund University School of Economics and Management

Since the seriousness and urgency of climate change has surfaced during the last decade, researchers, experts, and even the pope have argued that dealing with it is a moral issue. However, emissions keep rising and it seems as if few people in the north are ready and willing to make any substantial lifestyle changes to minimize the potentially catastrophic consequences, mainly to the south. International treaties and agreements are being put into place but without grass-root support and willingness to understand and change behavior, the success of these policies is questionable. Excessive consumption and travelling is often pointed to as high-emitting consumer behaviors and consumers and citizens are asked to change behaviors. Often, there is a discussion of blame and of which groups should take the lead in a change; be it politicians, companies or consumers. Against this background, it is important to understand how consumers reason around climate change and other sustainability issues, especially in terms of morality. As such, there are several different theoretical frameworks that can aid in developing communication addressing consumers and thus increasing the likelihood of a less climate impactful consumption. The purpose of this study is thus to further the understanding of how climate change is viewed as a moral issue by consumers, and based on this, propose how climate change communication by different stakeholders can be improved. A questionnaire survey was developed using several morality theories and concepts that were related to sustainability issues in general and climate change in particular. In total, 1144 respondents returned the questionnaire comprising a response rate of 23%. Results from a range of different analyses show that some moral attitudes are more related to the willingness to act for climate change mitigation than others and also that there are differences among consumer groups. Implications based on the results and suggestions for climate change communication are presented, as well as suggestions for further research.

50 Water Footprint Assessment to Inform Sustainable Food Production in South Africa

Henry Jordaan, Frikkie Mare, Enoch Owusu-Sekyere, Morne Scheepers, Pascalina Mohlotsane, Phoka Nkhoua

Department of Agricultural Economics, University of the Free State

South Africa is considered the 30th driest country in the world (DWA, 2012). The average rainfall is about 495mm per annum, ranging from less than 100mm in the Western part, to 1200mm in the Eastern part of the country. About 65% of the country does not receive enough rainfall for successful rain-fed crop production, and is used as grazing land (FAO, 2005). It is within this context that the agri-food sector in South Africa has to produce a sufficient amount of food for an ever growing population. Water footprint is considered a useful sustainability indicator in the agri-food sector (Ridoutt et al., 2010) to inform water users regarding the degree of sustainability with which water is used to produce agri-food products. The volumetric water footprint indicator is an indicator of the volume of freshwater consumed for the production of a product, measured along the whole supply chain of the product (Hoekstra et al., 2011). Importantly, the volumetric water footprint indicator is interpreted in the context of water availability to get an indication of the degree of sustainability with which water was used to produce the particular product. Despite the usefulness of the water footprint concept to inform sustainable water use, few studies have been conducted in South Africa to assess the sustainability with which freshwater is used for food production. Thus, currently there is rather limited scientific evidence to inform water users on the sustainable use of water when producing agri-food products. The Water Research Commission (WRC) has realized this lack of knowledge, and is currently driving a new research agenda on water footprint assessment to inform sustainable water use for food production in South Africa. This paper reports on findings of two projects (K5/2397//4 and K5/2553//4) assessing the water footprints of selected crops (maize, wheat, sunflower seed, sugar cane and Lucerne) and some animal products (milk, poultry and beef) in South Africa. The results show that the volumetric water footprint indicators of the respective products do relate relatively well to global averages. The largest share of the water footprint of derived crops products (i.e. bread from wheat) can be attributed to the production of the primary crops under irrigation. More

than 90% of the total water footprint is related to the production of the primary crops. Similarly, the results show that the largest share of the total water footprint of animal products can be attributed to the production of the crops produced for feed for the animals. Thus, when aiming to improve the water footprint of agri-food products, special attention is required to ensure that the primary products are produced in a sustainable manner. Interestingly, there also proves to be substantial variation in the volumetric water footprint indicators for the different provinces of South Africa. Thus, local, context specific information is important to accurately inform water users in a particular production region on the sustainable use of freshwater for food production.

51 A Survey on the State of Energy Efficiency Adoption and Related Challenges Amongst Selected Manufacturing SMMEs in the Booysens Area of Johannesburg

Njabulo Kambule

South African Geography Association

The Small Micro Medium Enterprise (SMME) sector plays a critical role in the economy of South Africa by reducing poverty and providing employment. South Africa has about 6 million SMMEs that employ more than 61% of citizens and contribute about 37% to the Gross Domestic Product (GDP). The growth and development of the sector over the years has however been compromised and threatened by the shortage of electricity and increasing electricity tariffs. Whereas large companies can manage to afford the adoption of energy efficiency measures in order to reduce energy costs, SMMEs have limited resources and may therefore struggle to afford energy efficiency adoption. However, there is a lack of scientific documentation about energy efficiency adoption amongst manufacturing SMMEs (M-SMMEs) in South Africa.

The purpose of the research was to assess the state of energy efficiency adoption amongst M-SMMEs, despite the challenges they experience. To achieve this research goal, the study surveyed and characterised the extent of energy efficiency adoption and also identified the drivers and barriers to energy efficiency adoption. Primary data were collected by means of surveys, making use of questionnaires. A sample of 30 firms was selected for the research.

Almost all (96%) firms regard EE as an opportunity. However, only 50% had adopted EE measures. Key drivers to adoption included the motive to reduce production costs, mitigate the impact of increasing electricity prices, gain competitive advantage and the payback period. The gap between EE perception and adoption was caused by several barriers like the lack of finance, skills and time. Among non-adopters, 60% indicated their willingness to be trained in EE. Based in the research findings, the study recommended improved capacity building through on-side workshops for M-SMMEs.

52 Human and Social Capital Development Contributions of the Richards Bay Minerals Industry Cluster

Shuhei Kato[1, 3], Anthony Black[2], Harro von Blottnitz[1, 3]

[1] Department of Chemical Engineering at the University of Cape Town
[2] School of Economics at the University of Cape Town
[3] Department of Chemical Engineering at the University of Cape Town

The South African economy has developed with its strong connection to the energy and capital intensive minerals extraction and processing industries. Rich endowments of coal and more than a century old mining sector in the country enabled the generation and supply of competitively priced electricity to capital intensive processing and chemical industries. Although the minerals industry cluster remains globally competitive at the present time, whether it can be a catalyst for sustainable development, economically, socially and environmentally is in question.

Field work was carried out in Richards Bay to analyse human and social capital formation contributions of the local minerals industry cluster. This town is the host of world class aluminium smelters as well as mineral sands mining and smelting, amongst other energy intensive industries, such as paper pulp and phosphate manufacturing. This analysis interrogates the importance of corroboration between various stakeholders, especially in relation to the Sustainable Development Goals (SDGs) 4 (quality education), 8 (decent work and economic growth) and 9 (industry, innovation and infrastructure).

Evidence found shows that the minerals industry cluster contributes to human capital development through well-established in-house training and their Corporate Social Responsibility (CSR) investment in enterprise and supplier development, education and primary health care. However, a more competitive and environmentally responsible industrial cluster would require more R&D and artisan training. Research and training institutions and government intervention have important roles to play in this regard.

One of the major challenges comes from the lack of social capital development in the past. The racially segregated development pattern in the region had left residents with huge disparities and a trust deficit. This prohibited collective actions within the community, except in the cases of

natural disaster responses and crime prevention. This is evidenced in the failure of a socio-economic development programme in the late 1990s due to the low level of community buy-in. The significance of the local minerals industry cluster remains undoubtedly high; however, a facilitative process of social capital formation is paramount to mitigate social distrust and create dialogues of values between different stakeholders.

53 Consumer Values and Attitudes towards Low Carbon Living: Finnish Perspective

Suvi Konsti-Laakso[1], Maija Leino[2], Anna Claudelin[2], Ville Uusitalo[2]

[1] Lappeenranta University of Technology, School of Business and Management
[2] Lappeenranta University of Technology

This study focuses on studying the values and attitudes of individual consumers towards current low carbon solutions for housing. Research has indicated that in order to promote the transformation towards a sustainable way of living, the role and behavior of individuals and households must be acknowledged. Moreover, the traditionally passive end-users such as consumers should be transformed to active players in the energy markets. Research has shown that from an individual viewpoint, housing, mobility, and food account for the great majority of household energy consumption and greenhouse gas emissions. This study focuses on energy-usage and production as it relates to housing. Many factors are known to influence household energy use, such as knowledge about energy use related aspects, motivation to save energy, and the ability to engage in energy saving. In this setting, values and attitudes towards sustainability and technology play a key role.

The aim of this paper is to present findings from a quantitative survey that focused on studying how individuals perceive current low carbon solutions for housing, such as the use and production of renewable energy and the use of energy efficient solutions. The survey was conducted in Finland in 2016 in two residential areas. The main research question is, "What attitudes and values can be identified towards sustainable choices in housing?"

This study contributes to the research on consumer engagement, which ultimately seeks to transform the traditionally passive end-users to active players in the energy markets. Moreover, the results provide applicable information and support for the commercialization processes of sustainable solution providers.

54 Analysing Landscape Change in the Karoo Rangelands

Juliane Krenz[1], Philip Greenwood[1], Brigitte Kuhn[1], Goswn Heckrath[2], Nikolaus Kuhn[1]

[1] University of Basel
[2] Aarhus University

The semi-arid rangeland areas of the Great Karoo region in South Africa have experienced a number of environmental and landscape changes. Approximately 200 years ago, agricultural activities increased when European farmers first settled the area. In response to changing land use, shifting rainfall patterns, and a higher demand for water, many dams and small reservoirs have been constructed to provide drinking water for cattle or to facilitate irrigation during dry periods. Nowadays, the landscape is characterized by complex gully networks incised into deep deposits of colluvium and alluvium, and most of the dams are filled with sediment and many have become breached, revealing sediment archives that can be used to analyse land use changes during the last 100 years.
In this ongoing project, a combination of analytical methods that include drone imagery, landscape mapping, erosion modelling, and sediment analysis have been employed to analyse landscape change. Sediment deposits from a silted-up reservoir were analysed for varying physicochemical parameters, in order to analyse erosion and deposition patterns. A sharp decrease in the total carbon content with decreasing depth suggests that land degradation during and after the post-European settlement most likely triggered erosion of the relatively fertile surface soils which presumably in-filled the reservoirs. It is assumed that the carbon-rich bottom layers of the dam deposits originated from these eroded surface soils.

55 Rangelands – a Closing Sink for Atmospheric Carbon?

Nikolaus J. Kuhn

University of Basel

The exchange of Carbon between land srface and atmosphere is subject to significant uncertainty. One reason is the lack of information on uptake by soil and, to a lesser degree, vegetation. These fluxes are usually inferred from measurements taken in or on the atmosphere and indirect net primary productivity observations. Even greater uncertainty exists on the impacts of land cover and soil quality change on Carbon fluxes over time. On cropland, soil degradation leads to C emission, while water erosion appears to induce a minor sink for atmospheric Carbon while dynamic replacement through photosynthesis lasts. The relevance of soil lateral soil movement and soil degradation in rangelands remains understudied, despite their serious degradation and large extent, globally covering twice the land area of croplands. This study attempts a simple risk analysis using available data on soil erosion and land degradation to assess the potential of erosion and degradation on rangelands to move Carbon first from land surface into sinks, and the subsequent effect of loss of erosion-induced loss of productivity on C uptake from the atmosphere.

56 Nitrogen and Phosphorus Lock-In – a Double-Edged Trap Generated by Rigidity and Poverty in Food Systems

Anna Kuokkanen, Helena Kahiluoto, Hanna Mäkinen

Lappeenranta University of Technology

System lock-in can have detrimental effects on future food security and the operating space for humanity, as it propagates unsustainable food systems through technological, institutional, and socio-economic path-dependencies and generates structures of disparate access to nutrients. This paper argues that nitrogen and phosphorus lock-in is reinforced globally by two distinct dynamics: rigidity and poverty traps, which undermine social-ecological resilience. Both traps represent a maladaptive system state, but have different dynamics and properties: rigidity trap is characterized with a low level of heterogeneity of entities, a low capacity to explore, and a low capacity to dissipate stress, whereas poverty trap has a low level of network connections, a low capacity for focus, and low average stress. The hypothesis is empirically tested in two contrasting country case studies, Finland and Ethiopia. Data is collected from publicly available sources and from numerous interviews in both countries. Finland, our case for developed countries, exemplifies the former situation where food systems are based on monocultures, maximization of efficiency and output, and on centralization and standardization, hence transgressing planetary boundaries of nutrients. In contrast, the latter case characterizes the situation in Ethiopia, our case for developing nations, where locally adapted and diverse small-scale farming thrives, but food needs are not sufficiently met, due to the systemic failures in access to fertilizers, technology, seeds, and other assets. Special attention is paid to the different levels and scales at play and their interaction. The assumption is that the global market only exacerbates the entrapment locally by disregarding the non-substitutable and disparate nature of nutrients. This analysis can provide new insights into both the theory and practice of escaping the lock-in. Furthermore, a better understanding of maladaptive traps can assist in linking cross-scale dynamics of social-ecological resilience from the local to the global scale.

57 Comparing Two Prominent Approaches to Assess Water Use Sustainability and Their Implications for Food Systems

Anna Kuokkanen, Maija Leino, Ville Uusitalo

Lappeenranta University of Technology

Unequal distribution of freshwater reserves critically determines the differences in agricultural productive capacity around the planet. Since over 80% of water use goes towards food production, water governance is intrinsically linked to food systems and food security issues. Thus increasing scarcity urges the consideration of more sustainable governance of freshwater use, while not undermining food security. In order to answer questions such as where and how food should be produced and consumed in terms of more sustainable and efficient water use, it is important to understand the approaches and methods used to assess the sustainability of water. Currently the two most prominent techniques, Life Cycle Assessment (LCA) ISO standard and Water Footprint Network (WFN) approaches, both quantify freshwater use, but apply different methods to assessits sustainability. LCA has long traditions in assessing various environmental impacts of products or production systems from the cradle to the grave, while WFN originates in water resource management. Shortly put, LCA aims to indicate the water use impact by contrasting water abstraction to the local water scarcity conditions, whereas the WFN indicates the overall water appropriation (constituted by blue, green, and grey water) driven by consumption. Herein, the aim is to outline the strengths and weaknesses of the two approaches based on the literature. More importantly, the aim is to analyze and demonstrate through empirical cases, the differences in their implications for food systems. For the second objective, empirical data from three contrasting countries are used. LCA and WFN based water footprints are determined in the context of food production in Finland, Iran, and Namibia, with each country having different food systems, food security status, and freshwater reserves. These findings will contribute to the debate in the food-water security nexus, which is instrumental for sustainability governance in both food and water domains.

58 The 2015 Mobile Lifestyle Aspirations Survey

Sylvie Landrième, Christophe Gay, Marc Pearce

Mobile Lives Forum

A future - however sustainable - can only be considered if it meets the diverse needs and desires of a population. With this in mind, in 2015/2016, the Mobile Lives Forum launched its first large-scale survey on people's aspirations via an online panel, consisting of a representative sample of more than 12 000 (2,000 per country) in France, Spain, Germany, the US, Turkey and Japan.

The study is based on two assumptions. First, that people are as legitimate as any expert in discussing the future of the society in which they live. Second, that people are capable of envisioning a future that goes beyond next week's shopping list or the purchase of their latest iPad.

In order to study these assumptions and to understand people's aspirations beyond the requirements of everyday life, the survey asked respondents to project themselves into a future both distant and ideal - into a utopian lifestyle, one they aspire to for themselves and their children and grandchildren. In this way, the survey aimed to capture the broadest depiction of people's ideal lifestyle (work, family, leisure, vacations, etc.) while investigating the role mobility could play in realizing this ideal.

The survey results show similar aspirations in all six countries, most of which set themselves in contrast to contemporary lifestyles, particularly against the trying conditions of our fast-paced lives and the tensions resulting from daily commutes. The results also show that the majority of participants consider global warming to be a serious issue that needs to be urgently addressed. This coincides with individual aspirations, which emphasise greater consideration for environmental issues through a reduction of daily travel or more collective use of transport infrastructures, something we observed in all of the participating countries. Finally, within a framework of collective involvement, participants may even consider adapting their individual lifestyles to respond to the imperatives of the environmental crisis.

These results provide many positive indications that mobility policies focused on creating sustainable solutions will be well-received in the public sphere, especially when these mobility strategies are in line with and respect individuals' aspirations and dreams for the future.

59 Corporate Environmental Engagement in China

Cubie Lau[1], Zinette Bergman[2], Manfred Max Bergman[3]

[1] University College Dublin, Singapore
[2] University of the Witwatersrand
[3] University of Basel

China is in the process of institutionalizing corporate environmental engagement, which is of utmost importance not only nationally but also globally, considering its economic output and manufacturing base. For many economic, social, and political reasons, environmental engagement is firmly embedded in political discourse, which defines environmental responsibilities not only as one of the main pillars of the "harmonious society" but also through legal frameworks, such as the 2008 *Guidelines to the State-Owned Enterprises Directly Managed Under the Central Government on Fulfilling Corporate Social Responsibilities*. In addition, various financial incentives, such as taxation schemes on energy, progressive green credit schemes, and environmental disclosure policies for publicly-listed companies have been introduced. In this way, China provides multiple political, legal, and economic incentives to encourage corporations to embrace environmental responsibilities. However, given the priorities of Chinese corporations, this paper deals with the following questions: How do environmental incentives translate into corporate practice? Which environmental practices do companies operating in China engage in? How do leaders in corporations operating in China justify their environmental activities?

In this paper, we examine the interpretation and justification of corporate environmental engagement by business leaders based on anonymized interviews conducted with 41 CEOs and senior managers of large corporations in China. We contrasted the corporate environmental engagement of State Owned Enterprises (SOEs), Privately Owned Enterprises (POEs), and Multinational Corporations (MNCs), employing Content Configuration Analysis. We first identified the range of corporate environmental engagements, developed a typology thereof, and explored justifications provided by the respondents. By mapping different environmental engagements and justifications across different types of corporations, this study shows not only how business leaders conceptualize

and put into practice their understanding of environmental engagement in China, but how different environmental strategies and incentives may be more advantageously pursued in different contexts. Accordingly, this research aims to contribute to context-specific, culture-sensitive, and future-oriented research on corporate sustainability in China.

60 Cassava Processing Systems and Effluent Management Techniques in Southwest Nigeria: Challenges and Environmental Risk Implications

Nurudee Samuel Lawal[1], Kolawole Ogedengbe[2], Olukayode Smith Ojo[3]

[1]Department of Agricultural and Mechanical Engineering, College of Engineering and Environmental Studies, Olabisi Onabanjo University, Ibogun Campus, P.M.B. 5026, Ifo, Ogun State Nigeria
[2]Department of Agricultural and Environmental Engineering University of Ibadan, Oyo State, Nigeria
[3]Department of Civil Engineering, Faculty of Engineering and the Built Environment, Tshwane University of Technology, Pretoria South Africa.

Growing opportunities in cassava-root value addition through processing have resulted in an increased number of small and medium scale processing factories which generate huge volumes of solid and liquid wastes that have detrimental effects on the environment. This study examines fresh water consumption patterns, effluent generation, and wastewater disposal techniques among cassava-root processors in southwestern Nigeria with the aim of highlighting their impact on the environment. Structured questionnaires were administered randomly to obtain data from 60 cassava processing centres scattered across the study area. This study observed that wet fufu paste processing centres were dominant (81%) and generated the highest volume of organic wastewater with high **BOD** (1750–1872 mg/l), **COD** (24,000–56,000 mg/l), **HCN** (0.26–0.64 mg/l), and low pH (3.73–3.81). Also, inorganic constituents like sodium, calcium, magnesium, phosphate, and heavy metals were found in relatively low quantities in the effluents. About 3,586 m^3 of fresh water is required to process one tonne of cassava roots with 91.5% of this disposed as wastewater. Of the methods of wastewater disposal examined in this study, land surface was 51.5%, while open drainage and nearby streams were 45.9% and 2.6%, respectively. Land degradation, surface and ground water pollution, and high environmental risks were observed in the study area investigated. Finally, some processing practices and alternative sustainable solutions that can help reduce environmental risks and the menace of poor waste management and disposal among processors were proposed.

61 Additive Manufacturing Aided Product Development Processes—Potentials for Economic and Environmental Benefits

Maija Leino, Ville Uusitalo

Lappeenranta University of Technology, Finland

Additive manufacturing (AM) is a manufacturing technology used to fabricate parts from a 3D model, usually by adding material layer by layer. In the beginning of the development of the technology, it was mainly used for building prototypes. The technology has matured significantly in the 2000s and it can now be used to produce end-use parts as well. Still, the technology has the potential to be used in product development processes. In some cases, there has been the possibility to test the functionality of metal-end products with a plastic AM manufactured prototype. AM aided product development processes can provide economic benefits, for example, through 1) reduced time consumption in the product development process because of the possibility of acquiring prototypes more rapidly and 2) cheaper prototype costs. Reductions in environmental impacts can be attained, for example, by reductions in prototype manufacturing environmental impacts compared to traditional routes of prototype manufacturing. The most significant environmental impact reductions are achieved due to increased material and energy efficiency throughout the life cycle.

In this paper, the potential of AM aided product development processes to attain economic and environmental benefits is studied through a literature review and interviews conducted in the manufacturing industry. The chosen case studies from industry were AM of plastics—mainly material extrusion and powder bed fusion based processes— used to manufacture prototypes. The possibility to fabricate prototypes from plastics by AM instead of, for example, machining or injection molding may provide these above-mentioned possibilities of environmental and economic benefits. In addition, this paper collects information for more detailed future sustainability analysis of AM processes.

62 A Water–Energy–Food Nexus Perspective for Addressing the Sustainable Development Goals in South Africa

Tafadzwanashe Mabhaudhi[1], Sylvester Mpandeli[2], Luxon Nhamo[3], Amos Madhlopa[4], Albert Thembinkosi Modi[1, 5]

[1] School of Agricultural, Earth and Environmental Sciences, University of KwaZulu–Natal, P. Bag X01, Scottsville 3209, Pietermaritzburg, South Africa
[2] Water Research Commission of South Africa, Private Bag X03, Gezina, Pretoria
[3] International Water Management Institute (IWMI-SA), 141 Cresswell St, Weavind Park, Silverton, 0184, Pretoria, South Africa
[4] Energy Research Centre, University of Cape Town, P. Bag X3, Rondebosch, Cape Town 7701, South Africa
[5] Universiy of KwaZulu-Natal

The Water–Energy–Food Nexus has been adopted in South Africa for research and development as well as for a policy and planning perspective for efficient multi-sectorial governance and as a response to climate change challenges. However, the nexus remains an isolated topic due to lack of understanding of complexities and interlinkages between its components as well as the opportunities it offers. This study reviews strategic policies and legislation implemented in South Africa since 1994 that govern water, energy and food sectors and determines whether there was policy convergence between the three sectors. This was achieved by a review of scientific publications, international reports and case studies that serve as a best practice learning template for South Africa. The review showed that South Africa's broad policy framework advocates broader social and economic reforms of which access to water, energy and food security features prominently. There is recognition that South Africa is water scarce, faces energy insecurity and rising food insecurity. While several key policies and legislation are geared towards addressing these challenges, only a few explicitly recognise the interlinkages and interdependencies between water, energy and food sectors. They are addressed separately, often creating a duplication of efforts, a lack of synergies and convergence between the three sectors. This inadvertently creates policy contradictions and increases beaurocratic regulatory frameworks which frustrate sustainable

development. A water–energy–food nexus approach offers opportunities for increased cross sectorial coordination which could lead to improved service delivery. Most importantly, it offers opportunities for addressing several of the Sustainable Development Goals (SDGs 1, 2, 3, 6, 7, 8, 9, 11, 12, 13, 14 and 15). Adopting a water–energy–food nexus approach enhances the government's capacity to deliver on the SDGs and national priorities for social, economic and infrastructural development outlined in the National Development Plan—Vison 2030.

63 Water–Energy–Food Nexus: Opportunities and Challenges for Southern Africa

Tafadzwanashe Mabhaudhi[1], Sylvester Mpandeli[2], Luxon Nhamo[3], Amos Madhlopa[4], Albert Thembinkosi Modi[1, 5]

[1] School of Agricultural, Earth and Environmental Sciences, University of KwaZulu–Natal, P. Bag X01, Scottsville 3209, Pietermaritzburg, South Africa
[2] Water Research Commission of South Africa, Private Bag X03, Gezina, Pretoria
[3] International Water Management Institute (IWMI-SA), 141 Cresswell St, Weavind Park, Silverton, 0184, Pretoria, South Africa
[4] Energy Research Centre, University of Cape Town, P. Bag X3, Rondebosch, Cape Town 7701, South Africa
[5] Universiy of KwaZulu-Natal

Water, energy, and food are important components for poverty reduction, human well-being, and sustainable development within the Southern African Development Community (SADC). Water, energy, and food security remain integral to alleviating poverty in the region and achieving regional integration. However, increasing pressure on water, energy, and agriculture, which is also being exacerbated by climate change, threatens the region's sustainable development agenda. The objective of this paper was to review the region's water, energy, and agriculture sectors in order to identify linkages as well as opportunities for strengthening regional cooperation through the water-energy-food nexus. The review showed that, currently, the lack of horizontal linkages between sector plans for water, energy, and food challenges the adoption of a regional water-energy-food nexus. Of the three sectors, water resources governance provides meaningful opportunities for strengthening a water-energy-nexus approach to regional planning. This is because SADC countries share similar climatic and hydrological conditions and the majority of the region's water resources are transboundary. The same water resources are also key to irrigation and energy generation. In this regard, existing institutional arrangements such as watercourse commissions and the Southern African Power Pool could provide an initial platform for developing a regional water-energy-food nexus. Shared regional development objectives and priorities for achieving water, energy, and food security provide an impetus for adopting a water-energy-food nexus approach to planning.

64 Synthesis of a Plant-Based Dust Suppressant for Use in Coal Mines in Mozambique

Isaias Mutombo Mafavisse, Roberto Wagner Lourenço, Valquíria de Campos

UNESP

Opencast mining dominates coal production in Moatize. The ambient air quality and seasonal variations are described, revealing high pollution potential due to suspended particulate matter (SPM) and consequent impact on human health and environmental effects. One of the major challenges is to minimize the impacts resulting from air emissions caused by Mozambique's coal mining activities. Thus, the purpose of this study is to use *Pinus elliottii var. elliottii* as a raw material for the formulation of a dust suppressant, a technique that complies with environmental standards but whose use has shown a global downward trend. Before producing the dust suppressant, the rosin was sulfated to reduce its viscosity. The basic formulation of the dust suppressant made of plant extracts included 5 wt.% of active ingredient and 2.5 wt.% of hygroscopic salt, and a low concentration of calcium resinate to ensure rapid drying of the product. Three suppressants were examined in these experiments: water, calcium chloride and plant extract. Experiments were conducted to measure PM_{10} and $PM_{2.5}$ separately. The interface between the undeformed coal matrix and the suppressant film was examined by confocal laser scanning microscopy. For an agent to show any value, it must be more effective than water. Each experiment was performed three times to ensure reproducibility. Walker's sink test was employed to evaluate the ability of the suppressant to immerse fine particles. The suppressor made of plant extract (*Pinus elliottii*) was as much as 90% more effective than water and calcium chloride in reducing both PM_{10} and $PM_{2.5}$ levels. The genus *Pinus* is an abundant and low cost raw material which has a chemical potential for the development of new *high-value-added products*. The initial results are promising and represent not only an environmental advantage but also an important gain for communities located in the surroundings of coal mines.

65 Partnership between Commercial Banks and Government in Facilitating Funding Opportunities for Female Entrepreneurs in South Africa

Zinzi Magoda

Cape Peninsula University of Technology

The Global Entrepreneurship Monitor (GEM) found that the South African financial system has traditionally catered to large corporate clients and has neglected small enterprises.
Many of these small enterprises are now set up by females. Unfortunately, they face the challenge of securing financing. This is a problem common to many countries in the GEM scope of analysis, with the evidence suggesting that female entrepreneurs across the globe find it difficult to secure formal financing for a business venture unless they have assets to be used as security. Finance is viewed as one of the core challenges for **SMME** development as a whole in South Africa.
This study used the qualitative deductive approach, utilising in-depth semi-structured interviews, which enabled the participants to disclose important information relating to the study.
The population comprised of business owner-managers. A self-administered questionnaire was sent to owners and a total of 50 usable responses were received. The data were analysed qualitatively using themes. The results indicate that easier access to funding from all financial institutions and government organisations was necessary, and the lack of such provisions was a barrier to success for a business venture.
Financial institutions and government should meet on a regular basis to identify challenges faced by female entrepreneurs concerning access to funding. For instance, banks can learn about the unique challenges that these female entrepreneurs face daily. Government has a duty to provide an enabling business environment, which should include easier access to financial assistance, without disempowering red tape that creates unnecessary restrictions concerning assets as security to obtain financial assistance.
Although the government has tried to put in place policies and institutions with the aim of improving access to finance by female entrepreneurs, its success has been minimal. Therefore, financial institutions such as

commercial banks should also play a vital role not only in assisting female entrepreneurs with finance but also in offering non-financial support services such as provision for financial management skills and mentoring.

66 Sustainable Production of Honeybush Amongst Smal-Scale Producers: Barriers and Opportunities.

Rhoda Malgas, Shayne Jacobs, Karen Esler

Department of Conservation Ecology and Entomology, Stellenbosch University

Production and sale of sought-after honeybush (*Cyclopia spp.*) biomass present a compelling solution to rural poverty among land-users located in the areas of production. During a year-long participatory action research (PAR) study at Genadendal in the Overberg, our aim was to investigate the barriers land-users face in establishing and sustaining honeybush production. Data was drawn from monthly meetings and intermittent workshops with eight farmers participating in a honeybush trial in the rural village. Supplementary data was gathered from two parallel studies on local ecological knowledge (LEK) of honeybush amongst land-user communities in and around Genadendal conducted around the same time. Adopting a grounded theory approach data was analysed in Atlas t.i. and three clusters of barriers to sustainable production were identified: biophysical, institutional and interpersonal. The LEK studies offered context to the challenges, and were a source of inspiration to the farmers to find possible solutions. At the request of the farmers, focus group discussions during a Community-2-Community Knowledge Exchange Visit to more experienced small-scale roobios producers revealed similar challenges, suggesting that these barriers are not limited to aspirant small-scale honeybush producers, but may have implications for production systems amongst small-scale producers elsewhere in the CFR. We juxtapose these challenges with the ecological characteristics of the resource in question, pointing out further opportunities for sustainable production amongst small-scale producers. The implications of our research are significant for other Fynbos-based industries included in recent policies aimed at improved rural livelihood options for small-scale producers.

67 Ecology and Epidemiology of Wild and Domestic Suids With Special Reference to African Swine Fever (ASF), Foot and Mouth Disease (FMD) and Aujeszky Disease (AD) in Ndumo Game Reserve (NGR), South Africa.

Cynthia Mapendere[1, 3], Eric Etter[2], J. Willem H. Ferguson[1, 3], Ferran Jori[2]

[1] Centre for Environmental Studies, University of Pretoria
[2] CIRAD, UR AGIRs, Montpellier, France
[3] Centre for Environmental Studies, University of Pretoria

Wild pigs can be central in the transmission of livestock diseases depending on the geographic setting and contact rate with domestic pigs. Though a number of studies have been conducted concerning the role of wild pigs in the epidemiology of various diseases, studies targeting population dynamics and farmer to consumer value chain remain patchy. This is particularly true in Southern Africa where very limited work has been done in the field of pathogen transmission between wild and domestic pigs, with the exception of ASF, but often without considering the populations dynamic or the role of the value chain in this transmission. There is therefore an urgent need to investigate wild-domestic animals' demographics, to assess the value chain and the potential existence of an interface between wild and domestic suids. The major objectives of the study are to:

11. Conduct a census of wild pigs (warthogs and bush pigs) in (NGR) and its wildlife-livestock interface
12. Understand the domestic pig value chain in Mathenjwa community
13. Quantify the interaction (spatial and temporal overlap) between wild and domestic pigs in Mathenjwa community
14. Determine whether warthog and bush pigs in northern KwaZulu-Natal play a role in the epidemiology of diseases such as ASF, FMD and AD.

To satisfy the stated objectives, data will be collected using transect counts, questionnaire survey, focused group discussion, collection of ticks, and collection of blood samples. Through understanding the extent which wild

and domestic pigs interact in NGR, this will enable setting up early warning systems and ultimately controlling the spread of diseases such as FMD, ASF and Aujeszky as the area has been declared ASF and FMD control area. This will also enable crafting more effective measures to curb transmission of the disease to domestic pigs and more directed intervention in the event of an outbreak.

68 Exploring the Untapped Potential of China's Role in African Agriculture Development

Lawal Marafa

Director, Postgraduate Programme in Sustainable Tourism Department of Geography and Resource Management, The Chinese University of Hong Kong

China is a leading investor in Africa, and this has also manifested in its role in Africa's Agricultural Development. The development of African agriculture is crucial and it is necessary for the sector to be successful so that it can help in rural development, poverty alleviation and in the pursuits of some indices of sustainable development goals. Since the 1960s, global agricultural production has increased significantly while that of Africa has grown by about 4–5% over the last two decades despite the availability of arable land and with up to 70% of the population being involved in some sort of agricultural activities.

Over the years, China, whose population comprises 35% farmers, has recorded successes in food production, poverty alleviation and essentially food security, despite challenges in limited arable lands and huge population. Given that China has succeeded in its agricultural sector, there is room for African agriculture productivity to benefit from the experience that China has in technology and efficiency, given that Africa has about 25% of the world's arable land but currently produces just about 10% of the global agriculture output. Africa indeed will have to focus on producing higher agricultural growth and productivity to enhance its development potential.

In order for agriculture to be developed, there is the need to further understand the context in which agriculture is placed on the continent. How can this be reversed to achieve sustainable solutions is a question that will need to be addressed. While agriculture is the mainstay of African societies, it remains rudimentary and undervalued. There are many reasons for this rather low state of agriculture in Africa. It is the aim of this paper to identify these reasons, discuss the consequences and propose ways in which the potentials of the industry can be harnessed while understanding and discussing strategies and successes recorded by China.

69 Sustainability assessment of the smallholder beef cattle production system using farmer selected indicators in South Africa

Tawanda Marandure[1], Cletos Mapiye[1], Godswill Makombe[2], Kennedy Dzama[1]

[1] Stellenbosch University
[2] University of Limpopo

Ninety-five farmers were involved in deriving a set of social, environmental and economic sustainability indicators which were used to assess sustainability of the smallholder cattle production system in Ncorha and Gxwalibomvu communities in the Eastern Cape, South Africa. The derived indicators were scored on a five-point Likert-type scale and aggregated to provide a score for each of the three dimensions of sustainability and the net sustainability score. Aggregated sustainability scores were grouped into three categories; non-sustainable (<33%), conditionally sustainable (33-65%) and sustainable (>65%). Most respondents indicated good to excellent operational levels for social indicators including access to information (67%) and gender balance (66%). For environmental sustainability, respondents indicated very good to excellent operational levels for air quality (100%) and chemical use (85%). Social grants (54%) were the dominant economic indicator with income levels of less than R1000/month. Cattle income was the least common economic indicator but had the highest income levels (>R3000/month). Aggregate sustainability scores showed that cattle production systems in Ncorha and Gxwalibomvu, respectively, were socially (48.2% and 56.6%) and environmentally (54.2% and 57%) conditionally sustainable but economically (15.7% and 10.8%) non-sustainable. Overall, cattle production systems in Ncorha (39.4%) and Gxwalibomvu (41.5%) were conditionally sustainable. Interventions to improve the economic dimension of sustainability while, simultaneously maintaining or improving the social and environmental dimensions of sustainability of the system were recommended.

70 Sustainability and Food Security

Tawanda Marandure, Kennedy Dzama

Stellenbosch University

Undoubtedly, the consensus among researchers is that the concept of sustainable agriculture need to simultaneously fulfil the triple goals of environmental protection, economic viability and social justice. However, many South Africans still consider it an elitist concept of little relevance to their day to day lives and later alone food security. This paper reviews literature that points out examples of unsustainable conventional agriculture and argues that sustainable agricultural practices are pertinent for food security, environmental and overall well-being of South Africans. Rate of top and nutrient soil loss from agricultural fields is estimated to be 12.3 t/ha, 30-50% of N and over 45% of P, respectively. Siltation reduces the capacity of local dams and exacerbates water shortages. About 20% of surface and groundwater is contaminated by atrazine which is a pesticide and herbicide residue that affects prenatal and early childhood sexual maturation. The rising cost of inputs in intensive agriculture is likely to push the food prices up and diminish food security. Residual chemicals in agricultural products has been linked to various diseases. Adoption of sustainable agricultural practices is critical to reverse most of the negative effects of conventional agriculture.

71 Delivering Global Impacts Through Certification and Ecolabelling

Michael Marriott, David Agnew, Catherine Longo

Marine Stewardship Council

The Marine Stewardship Council (MSC) is the world's leading certification and eco-labelling program for sustainable seafood. The MSC has developed a scientifically-robust standard against which fisheries can be assessed in order to demonstrate that they operate in a sustainable manner with low environmental impacts. Certification can help fisheries access new markets, while the presence of ecolabels on certified products allows seafood consumers to make informed sustainability choices.

Since 2010, the volume of MSC certified seafood has almost doubled, to 10% of global wild-caught seafood in 2016. Stakeholder engagement lies at the heart of the MSC's third-party assessment process, with sound management most often delivered through collaboration.

MSC data (taken from the Global Impacts Report 2016) show that over the course of their certification, 94% of certified fisheries are required to make at least one improvement to strengthen or further monitor the sustainability of their operations in order to maintain their certificate. By the end of 2015, 281 fisheries had made 876 improvements, including the reduction of bycatch and the development of best-practice management plans.

Highlighting these improvements, the report also acknowledges the need for greater representation from fisheries in the developing world. These numbers are rising and the MSC has developed tools, funding, and training initiatives aimed at making certification more accessible. The UN Sustainable Development Goal 14 on oceans reinforces the importance of small-scale and developing world fisheries for food security and economic development.

Here, we present an overview of the role of market-based solutions in shaping sustainable seafood consumption and in meeting the UN Sustainable Development Goal for marine conservation. We demonstrate how the MSC's seafood eco-labelling scheme is contributing to improvements in global fishing practices and to sustainable development.

72 Food Waste–Who's to Blame?

Nadene Marx-Pienaar, Nadine Cynthia Sonnenberg, Shandre Candiotes

University of Pretoria

During the twentieth century, consumer behavior morphed from the simple social act of acquiring goods and services to maintain a households' daily life to the daily act of satisfying personal needs\greed to such an extent that it not only undermined the values of current societies, but also jeopardized the fulfillment of future society's needs. The 'shop till you drop' syndrome (that is, the ever-increasing spiral of over-consumption) coupled with ideologies such as the 'customer is king' (that contributed to consumers' ill-sense of entitlement and lack of responsibility) has become a characteristic of present-day societies around the globe. In terms of food consumption, this is reflected not only in the manner in which consumers procure and consume their food products, but also in the manner and amount of waste generated. It is estimated that the average person produces nearly 220 kg of food waste annually, which adds up to approximately 70 million tons, making it the third largest component by weight of landfills. Not only does this waste have a negative impact on the natural environment as the methane gas generated from food waste is 20 to 25 times more potent than CO_2; it is also costly in terms of the country's economic bottom line. Although the issue of food waste has risen to the top of various political, academic, and industry agendas, and governmental policies do encourage a greater awareness which includes the implementation of strict waste management principles, many consumers unfortunately seldom acknowledge their role/contribution towards food waste and are more inclined to lay the blame and responsibility at the feet of the industry, such as food retailers and/or Government. This research presents empirical findings about consumers' attribution of blame regarding food waste.

73 Changing the Way We Treat Death: From Disposal to Positive Contribution

Meredyth Mellor

Transfauna Ltd

Reality: The phenomenal human body is nurtured from conception to death by our 3 most precious resources; our Air, Water and Soil. Aged 27, I found myself unexpectedly preparing my final wishes for my own body. Sea Burial was my choice but to my disappointment I learned that it is considerably more complicated and polluting than simply becoming 'fish food'. Burial, I discovered, is far from becoming 'worm food'. It pollutes the soil and water courses with leachate and is inefficient - tying up scarce land for protracted periods. The human body is >75% water which makes cremation fundamentally inefficient as well as heavily polluting the air. Response: Time served in UK funeral industry alongside our combined wider experience and expertise, provided the foundation for our team to develop a low cost, low energy, sustainable choice for our bodies after death. We have developed a method for the accelerated composting of the human cadaver, within a biosecure vessel, with minimal emissions and in a dignified way. Careful consideration of traditions, beliefs, religion and cultural sensibilities was essential throughout the development. We are developing a dedicated neonatal pod. We've blended the natural process with cutting edge technology to transform the body to dry, organic, reduced remains. The main by-products of our method are water and ammonium salt. This method is not reliant on fossil fuels. We aim to support re-localisation of funeral services, work with providers of current methods, maintain transparency and fair pricing.

Solutions such as this have the potential to make a significant contribution to the urgently needed reduction in emissions and restoration of the soil. Memorial trees & shrubs will contribute to cleaning the air, enhancing the soil and helping reduce erosion. Globally over 40 million people die each year. Replacing disposal with a positive contribution system is essential.

74 On the Potential of Forest Ecosystems to Supply Forage Resources to Managed Honey Bees: Implications for Sustainable Beekeeping Activities and Pollination-Based Agriculture in Limpopo Province (South Africa)

Sylvanus Mensah[1], Ruan Veldtman[2], Thomas Seifert[1]

[1] Forest and Wood Science, Faculty of AgriScience, Stellenbosch University, South Africa

[2] Department of Conservation Ecology and Entomology, Stellenbosch University, Matieland, South Africa

Honey bees play a vital role in the pollination of flowers in many agricultural systems, while providing honey through well managed beekeeping activities. With the worldwide decline in wild pollinators, crop pollination in agriculture fields has become increasingly reliant on managed honey bees. Managed honey bees in turn, rely on the provision of pollen and nectar for their survival and colony productivity.

We used forest inventory data (in Limpopo province, South Africa) and species-specific nectar and pollen values, to study the potential of mistbelt natural forests to supply foraging resources (nectar and pollen) to manage honey bee plants. Specifically, we explored (1) the spatial availability of honey bee plant species, and (2) the temporal availability of honey bee forage.

Results showed that up to 50 % of the overall woody plant richness were honey bee plant species, with varying flowering periods. The bee plants' flowering period was spread widely over a year, and the highest potential of forage supply was observed during the last quarter.

The results emphasised the opportunities for beekeeping activities, and the possibilities to consider these forests in the apiculture calendar of the area. Honey bee hives can be placed close to these forests during the peak forage period, to maintain the bee colonies. On the one hand, the benefits from the beekeeping activities can serve to contribute to the costs of promoting the conservation of these forests. On the other hand, deciduous and sub-tropical fruit fields in the surrounding environments of these forests could benefit from the pollination services. Furthermore, for crop fields

which are isolated from these natural forests, field edges could be afforested using the important bee plant species, as identified in this study. This will help to attract honey bees, and also contribute to sustain pollinator diversity at the proximity of these agricultural fields, thus increasing the benefits of local conservation and pollination services.

75 Productive Uses of Energy: Gender and the Informal Sector

Nthabiseng Mohlakoana[1], Jiska de Groot[2], Hans Bressers[1]

[1] Department of Governance and Technology for Sustainability (CSTM) (www.utwente.nl/cstm) University of Twente, P.O. Box 217, 7500 AE, Enschede, The Netherlands.
[2] Energy Research Centre, University of Cape Town (www.erc.uct.ac.za) Rondebosch, Cape Town, South Africa.

Unequal access to economic opportunities between men and women is more prominent in developing countries than it is in developed countries. There are various contextual factors that contribute to such inequality. One of the survival mechanisms that is used by the poor in developing countries is to create income generating opportunities in the informal sector. In many developing countries, the informal sector is the most important source of employment mainly due to the ease of entry and participation. The Informal Food Sector is dominated by women where they are active in food preparation and processing. This sector is also one of the most energy intensive where heating (among other energy needs) is the important need for processing various food products. This paper aims to bring together results from literature and a field survey from three African countries to illustrate women's and men's participation in the Informal Food Sector and the role gender plays in the access and use of energy sources in this sector.
Energy transitions in developing countries raise a number of issues that are often taken for granted at both policy making and implementation levels. In the developing countries context, micro-enterprises owned and operated by men and women are a common strategy to guarantee income generation and day-to-day survival. Energy plays a very important role in ensuring that a majority of these enterprises continue to operate, even if it means their growth is not guaranteed. It is therefore important to use a gender lens in analyzing energy use patterns and finding energy solutions that consider the complex nature of informal micro-enterprises, particularly in the food sector. Using the results generated from a current study and from literature, this paper will highlight the energy use patterns of informal micro-enterprises and make policy recommendations that will take into

consideration the complex nature of energy use and transitions in the Informal Food Sector.

Presenters: Dr. Nthabiseng Mohlakoana, Dr. Jiska de Groot and Prof Hans Bressers

76 Offtake and Genetic Diversity as Indicators of Sustainability for Smallholder Sheep Farming Systems in the Western Cape, South Africa

Annelin Molotsi[1], Simon Oosting[2], Schalk Cloete[3], Kennedy Dzama[1]

[1] Stellenbosch University
[2] Wageningen University
[3] Western Cape Department of Agriculture

The purpose of this study was to measure sustainability of smallholder sheep farming systems by investigating offtake and genetic diversity (inbreeding rate) as economic and environmental indicators respectively. Questionnaires were conducted with 72 smallholder farmers in three districts of the Western Cape, 21 in the West Coast, 26 in the Karoo and 25 in the Eden district. The different issues addressed in the questionnaire were regarding the farming system employed by farmers, reasons for keeping livestock, as well as flock structure and size. Information on the average number of lambs sold per annum and offtake were obtained. Constraints experienced by farmers were recorded in the survey. Inbreeding coefficients were calculated using the Wright formula and a genetic analysis using OvineSNP50 beadchip and PLINK software to estimate the genetic inbreeding coefficient. Data were analysed using Excel 2013, to obtain summary analysis per district. SAS 2013 was used to test for differences between districts for the average number of lambs sold. Differences were observed between the three districts in terms of source of income, with crops being the main income for Eden, livestock for Karoo and salary for the West Coast. Differences were seen in the average number of lambs sold per year per district. The Karoo farmers were more commercially orientated than the Eden and West Coast farmers. Offtake increased as the inbreeding coefficient increased. Land availability (21%) to expand farming systems as well as fencing and infrastructure (17%) were the major constraints as perceived by smallholder farmers. The smallholder systems were found to be economically unsustainable, whereas by environmentally using inbreeding as an indicator, they were sustainable.

77 The German Energiewende – Promoting Renewable Energy for Worldwide Expansion

Felix Muesgens

Brandenburg University of Technology

The Energiewende in Germany is unique in how far the transformation in the energy system will go. It is also unique in its contribution to growth in electricity generation from renewable energy sources. For example, in the early years of the new millennium more than fifty percent of global capacity additions in solar power came online in Germany. At the same time, the costs of solar power, both in terms of capacity (US$/Megawatt) as well as per unit of energy (levelised costs of electricity generation, US$/Megawatthour), decreased significantly. The literature agrees that installing capacity leads to cost reductions. This is described as “learning”, “learning rates” are defined as the reduction in electricity generation costs per doubling of installed capacity. This paper brings together the German Energiewende with cost reductions in renewable energies. As learning rates differ between technologies, we analyse both solar and wind power.

Firstly, we look at empirical learning rates in the literature. Secondly, we analyse how much wind and solar power was built in Germany. As we feel it will be interesting for the participants of WSF 2017 the paper also gives a brief overview of the German Energiewende. Thirdly, we will analyse the share of the German capacity additions with respect to global RES expansion, i.e. what share of total solar (respectively wind) electricity generation capacity was built in Germany. Lastly, we calculate how much the German share contributed to global learning, i.e. cost reductions for both wind and solar power.

This topic is of crucial importance beyond the specific German case because it adds advantages to renewable energy promotion which are often neglected when cost-benefit-analysis are discussed. Furthermore, by showing that “spill-over” effects to other countries are significant, the results will have implications for setting up optimal renewable promotion schemes worldwide.

78 Patterns of Dekadal Rainfall Variation over a Selected Region in Lake Victoria Basin, Uganda

Isaac Mugume

Makerere University

Rainfall is one of the variables that has a direct impact on crop production, health and water resources. Sustainable and economic agriculture, which influences food security, requires a thorough investigation of rainfall variability. The March–May (MAM) seasonal rainfall is organized into dekads (ten-day rainfall totals) and dekadal rainfall variation over a selected region in the Lake Victoria Basin, Uganda is studied to assess intra-seasonal rainfall variability. The trend of rainfall and rain days are analyzed using the Mann–Kendall (MK) trend test and linear regression over the period 2000–2015. The results show an increasing trend of both dekadal rainfall amount and rain days within the third and seventh dekads, and a reduction over the first and the second dekads. The light rain days over the MAM season were increasing (MK: 0.35, p=0.0649). Although the trend of wet days over the same period was also increasing, it was not insignificant (MK:0.118, p=0.5576). However, the light rain days were decreasing during the third (MK: -0.523, p=0.0230) and seventh (MK: -0.414, p=0.0302) dekads, whereas the wet days were increasing during the same period, i.e., the third (MK: 0.376, p=0.0511) and the seventh (MK: 0.449, p=0.088) dekads. These results probably indicate a weakening on-set of seasonal rainfall. Therefore, to ensure sustainable food security and reduce risks of famine due to crop production failure, the accuracy of seasonal rainfall prediction should be enhanced and crop production should follow the issued seasonal forecast.

79 Seeds Without Borders: Towards Participatory Quinoa Variety Development and Seed Sovereignty in Rwanda, Ecuador, and the USA

Kevin Murphy[1], Leonardo Hinojosa[1], Nicolas Pichazaca Mayancela[2], Julianne Kellogg[1], Cedric Habiyaremye[1]

[1] Washington State University
[2] Mushuk Yuyay

As agricultural scientists strive for food security and sustainability, partnerships with farmers on a global scale are vital to the success of any project. The introduction of a non-traditional crop to a new region has the potential to increase cropping system and market diversity, enhance nutritional security, and improve yield stability. Quinoa is a highly nutritious crop with the capacity to grow and produce seed with excellent protein quality in highly saline soils, drought prone environments, and low-input farming systems. Global demand for quinoa is increasing rapidly, and farmers worldwide (the majority outside of South America) are attempting to grow quinoa for the first time in their home countries. However, major varietal differences in photoperiod sensitivity, disease and pest resistance, tolerance to heat, and other abiotic stresses can lead to less than optimal crop yield and even complete crop failure. Using an evolutionary participatory breeding approach, we developed multiple heterogeneous populations of quinoa and subjected them to natural selection and farmer selection across environments ranging from marginal to optimal. Here we report results from trials in Washington State, USA, and Cañar Province, Ecuador, and we describe new trials currently underway in two locations in Rwanda. This 'Seeds without Borders' approach allows farmers to grow these populations on their home farms, with often unique selection pressures and cropping system effects, and conduct selection among the segregating genotypes to develop resilient, diverse, locally adapted populations and/or homogeneous varieties with a combination of traits important to the farmers and to local markets. Through repeated cycles of selection, farmers become invested in their seed varieties, thereby enhancing seed sovereignty and food security in their region.

80 Benthic Macroinvertebrate Functional Feeding Groups Patterns in Afro-Montane Rivers Relative to Physical Variables Land-Use and Physical Variables in Southwestern Uganda

Peace Liz Sasha Musonge

Ghent University

In order gauge the spatial distribution of macroinvertebrate functional feeding groups (FFGs) relative to land use types and physical variables along 71 sites in the Albertine rift valley Rivers (ARVR) in southwestern Uganda Artificial neural networks (ANN) were applied to the data set. The relative abundances of 5 functional feeding groups (FFGs) were computed from macroinvertebrate data identified to family level. Each sampled site was differentiated using 5 physical variables (altitude, river type, velocity, sediment matrix, channel pattern) and 3 land-use variables (forest and shrub, developed areas, agricultural areas). The sites were first categorized using the Kohonen's Self-Organizing Map algorithm (SOM), according to the land-use and physical variables. To examine the variability of the macroinvertebrate communities, functional feeding groups (FFGs) proportions at all 71 sites were examined on the SOM trained with physical and land-use variables. When the riverine landscape was natural, functional feeding groups (FFGs) patterns responded to the upstream downstream gradient with physical variables. However, when the landscape was altered by agriculture or urbanization, the effects of land-use on functional feeding groups (FFGs) overcame the influence of the physical variables. The categorization of the landscape into forested, agricultural, and urban areas was relevant to detect changes in functional feeding groups (FFGs) patterns. In light of projected developments along riparian zones in the region, the use of SOMs to detect responses of functional feeding groups (FFGs) to landscape alterations at local scales represents a useful approach for ecological assessment of freshwater systems based on functional feeding indicator groups.

81 Developing Phosphorus Vulnerability Matrix and demonstrating its application for a developing country, like India

Madhuri Nanda, Arun Kansal

TERI University, New Delhi, India

Global Phosphorus scarcity has emerged as a concern having semblance with oil crises, in terms of its depleting resources, increasing demand and further, lack of Phosphorus substitutability in agriculture. With skewed distribution of global phosphate resources and reserves, the vulnerability of population in terms of meeting global hunger and malnutrition has come to the forefront. Worldwide agrarian economies are facing immense pressure in meeting its soil nutritional needs to ensure productivity and support livelihood of its agriculture-dependent populations. Assessing vulnerability, therefore, is critical to address mitigation and adaptation measures in any country. The current research is based on indicator-based approach to establish vulnerability accounting for indicators linked to Phosphorus exposure, sensitivity and adaptive capacity of the people. The indicators are designed to cover physical, economic, institutional, managerial and geo-political scarcity of Phosphorus. Indicator method helps raise awareness on the issue of global Phosphorus scarcity among various stakeholders; and also help identify Phosphorus vulnerable parts of the country, where more focused policy attention and intervention is needed to build better Phosphorus resilience. The paper discusses the case of India with its significant dependence on phosphate imports (90%), an agrarian economy with agricultural sector contributing to 18% of country's GDP in 2013-14 and 51% of its population dependent on agriculture for employment. The paper clearly establishes that India has high vulnerability to Phosphorus scarcity with low soil Phosphorus levels, prevailing poverty and malnutrition levels, and limited infrastructure and institutional capacities to address and build better Phosphorus resilience. Involvement and engagement with the stakeholders would be the next step to validate the findings from the matrix for necessary actions at the policy-level in the country.

82 Assessing Mine-Related Water Quality Using Remote Sensing

Aros Ndlovu[1, 2], Solomon Tesfamichael[1, 2]

[1] Department of Geography, Environmental Management and Energy Studies. University of Johannesburg. PO Box 524 Auckland Park 2006 Johannesburg South Africa
[2] Department of Geography, Environmental Management and Energy Studies. University of Johannesburg. PO Box 524 Auckland Park 2006 Johannesburg South Africa

Water is one of the most important substances on earth and is essential for the survival of all living things. Unfortunately, water quality conditions are becoming degraded due to various stressors, including land use, agriculture and pollution. The Witwatersrand, Gauteng, is an example of an area where water quality has degraded due to mining and related activities. Monitoring such degradation is an expensive task and involves a combination of field inventories and laboratory analyses. There is therefore the need to improve monitoring methods. Remote sensing of earth features has the potential to characterize earth features by utilizing the difference in spectral properties of objects. The purpose of this study is to assess the utility of remote sensing in estimating water quality parameters associated with mining activities. Products including individual band reflectance as well as spectral indices (Normalized Difference Water Index, NDWI, and mineral composite) were derived from Landsat-7 and ASTER images for water bodies in the vicinity of mining plants. Zonal statistics (maximum, minimum, mean, range, standard deviation) of these products were computed per water body. A multiple linear regression analysis was used to correlate the zonal statistics and a number of water quality parameters that were quantified using laboratory analyses. Results showed the highest estimation accuracy for magnesium using NDWI (R^2 = 0.76, RMSE = 10.5) followed by nitrate, using a combination of multiple bands (R^2 = 0.57, RMSE = 1.38) from Landsat data. ASTER yielded the highest accuracy for chlorine, using a combination of multiple bands (R^2= 0.63, RMSE= 17.7) followed by potassium, using mineral composite (R^2= 0.62, RMSE= 10.8). These results demonstrate the potential of a remote sensing tool in monitoring water quality associated with mining activities.

83 Quantitative and Qualitative Effectiveness of Environmental Impact Assessment

Leila Neimane

Faculty of Law, University of Latvia / Faculty of Law, University of Pretoria

For the purpose of this paper, sustainability is referred to as quantitative and qualitative effectiveness of environmental impact assessment (EIA), which is a consolidated approach to estimate and predict the consequences of projects on the environment.
The aim of this paper is two-dimensional. Firstly, on the one hand, it explores quantitative and qualitative effectiveness of the EIA in the context of the European Union (EU) and European Free Trade Association (EFTA), and on the other hand, the Southern African Development Community (SADC). Secondly, it analyzes the current quality control mechanisms in the selected group of the countries.
The author claims that quantitative and qualitative aspects of the EIA effectiveness are mutually interrelated and dependent.
One of the basic indicators of EIA qualitative effectiveness is the number of conducted EIAs per million of a population. However, as it has been revealed in European Commission's (Commission) studies, for example, the EIA Directive has been transposed so differently across the EU that significant disparities of this indicator can be observed, even in the member states of similar size. To illustrate the above-mentioned, the author provides examples of the data of individual countries that are comparable by their size, population, and presumable quantity of economic activities.
Here, the relationship between quantitative and qualitative dimensions of the EIA effectiveness appears. In 2009 and 2012, Commission has identified four main reasons for the differences of conducted EIAs: firstly, a high level of uncertainty from the part of authorities and developers on when an EIA is actually required; secondly, the modifications of the project plan during the screening in a way that an EIA would no longer be required; thirdly, the lack of capacity to ensure sound screening; fourthly, the variations of application of thresholds and case-by-case screening (problem of "unsystematic screening").
The latest EU Directive 2014/52/EU in the field of the EIA introduces the united quality control mechanism at the EU level. The quality requirements can be divided into two main blocks and are cumulative by character or, in

other words, two-sided. Firstly, they refer to the accreditation of competent experts who consult the developer. Secondly, they are directed to the capability of the competent authority to provide sufficient expertise when checking the EIA report. The author argues that recently introduced more stringent quality control at the EU will homogenize the number of the conducted EIAs in the member states (that are comparable), however, undeniably, it is possibly, to a certain extent, due to the wide formulations of the EU legal requirements. Against this backdrop, the situation in the countries of the EFTA and SADC is also compared.

84 Toward a Theoretical Framework for Studying Climate Change Policies: Insights From the Case Study of Singapore

Ai Sian Ng, May Oo Lwin, Augustine Pang

Wee Kim Wee School of Communication and Information, Nanyang Technological University, 04-39, 31 Nanyang Link, Singapore 637718

The world decided in Paris on 12 December 2015 to collectively take action to reduce global warming. However, the Paris agreement would only take effect when at least 55 countries submit by April 2017 their plans to cut global emissions by 55%.

To contribute toward realizing the global target, this research examined possible policy levers for inclusion in ratification plans. A case study of the measures taken by the Republic of Singapore, a low lying 716 km² island without natural resources in Asia, was conducted. Being vulnerable to climate change impact and yet having to ensure her survival while balancing her people's needs and economic progress with limited resources, the measures taken by this small country could offer insights on the possible policy levers which small states and states without access to alternative energy sources, could put in place for targeted end-users. This research thus sought to analyze the online policy documents posted by ten key agencies involved in implementing the national ratification plan in Singapore to answer the main research question of identifying the policy levers.

The model of pro-environmental behaviour (Kollmuss & Agyeman, 2002) anchored the thematic analyses, as its classification of external factors systematically categorized the contextual policy levers. A qualitative research analysis software, NVivo 10, was used to classify the proposed nodes. The findings suggested trickling down effects from international, national, organizational to individual levels and the need for a system perspective for policy makers to adopt in climate change mitigation efforts. The findings based on the conceptual model used for the research could offer theoretical insights for future studies of climate change policies which could inform and strengthen policy development as well as measure policy outcome.

85 Mobility Transitions: Between Scarcity and Austerity

Anna Nikolaeva[1,2]

[1] University of Amsterdam
[2] Utrecht University

In this paper I examine how scarcity has become a particularly strong driver for mobility transition policies. Scarcity of oil, finance, road space, time, clean air, and land are appealed to in a variety of settings to promote "smarter", greener and cheaper mobilities and mobility infrastructures in the face of the limits or finitude of something. Furthermore, given the on-going repercussions of the 2008 financial crisis, Eurozone crisis and other regional and national crises, rhetoric on saving and accompanied government led austerity policies intertwine with transport planning and imagining future mobilities. Some suggest that the "lock-in mechanisms", such as the persistence of automobility and investment into high-carbon mobilities infrastructure, that hinder transitions may be "amplified" by austerity policies in the Global North (Schwanen, 2013), while others investigate mobility solutions in the context of austerity that are beneficial for environment and social equity (Ferreira & Couto, 2015). In this paper I look at the broadly understood logics of scarcity, saving, and austerity as they animate or hinder mobility transitions across various case-studies.

86 Resource-Efficiency and Pollution Reduction Effects of Wood Stoves in Road-Side Food Preparation

Rissa Niyobuhungiro, Harro Von Blottnitz

University of Cape Town, Chemical Engineering

In urban Africa, informal street food trade is often accompanied by processing activities, including slaughtering, brewing, grilling, or cooking. Food and drinks are often prepared on open fires using wood as a fuel. When fuel wood is used, it generally emits smoke containing various pollutants.
A recent global study argued that the use of cleaner technologies, especially those relevant for the energetic aspect of informal production, would provide affordable net benefits to society in terms of public health, climate change mitigation, and food security, but without showing how this could be implemented in specific cases.
This study investigated whether a Cleaner Production approach would be beneficial and could work in informal contexts, focusing on the case of road-side food (chicken plucking) and drink production in the Nyanga area of Cape Town in South Africa. The use of fuel wood as a source of energy by informal road-side caterers was investigated with a main focus on how its users could prepare their wares more eco-efficiently, i.e., at the same time, at lower cost, and with less pollution and waste. The methodology combined qualitative and quantitative field observations in a case study setting with experimental work to determine the feasibility and the benefits of using efficient wood stoves.
The 'trader-size' wood stoves that were investigated show a very short payback time, offering 6-fold and 8-fold reductions in fuel wood usage and particulate matter emissions, respectively. Their thermal efficiency is 18%, while in their absence it is 3%. Heating 25 L of water to boiling point using a wood stove takes ± 40 minutes, compared to up to one hour with the traditional method (open fires).
These wood stoves are suitable for informal road-side caterers (chicken plucking). However, the caterers would need to adopt new pots that can be accommodated by the stoves.

87 Rethinking African's Hope of Achieving BioHappiness by 2050 in a Rapidly Changing Time

Catherine V Nnamani[1], Sola A Ajayi[2], Happiness Ogba Oselebe[3], Christopher Atkinson[4]

[1] Plant Taxonomy/Biosystematics and Conservation Biology Research Unit, Department of Biological Sciences, Ebonyi State University, Abakaliki, Nigeria
[2] Department of Crop Production and Protection, Obafemi Owolowo University, Ile-Ife, Nigeria
[3] Department of Crop Production & Landscape Management, Ebonyi State University, Abakaliki.
[4] Natural Resources Institute, University of Greenwich, Medway Campus, Central Avenue, Chatham Maritime, Kent, UK

Acknowledging that climate change is having negative consequences on the livelihood of the rural and semi-rural populace has engendered a desire to build resilience in most countries in Sub-Saharan Africa. One of such cost-effective approaches employed by local communities in South east, Nigeria is diversification of their narrow staple agro-biodiversity to include neglected and underutilized species (NUS). *Sphenostylis stenocarpa* (Hochst ex. A. Rich.) Harms. Beitr (African Yam Bean (AYB)) answered this call. Thirty-four accessions of AYB collected from South-east, Nigeria were bio-evaluated and then correlated with physiological seed quality data after standard methods. Multidimensional Analysis (MDA) for decision making tool was used to pool the desirable nutrients in all accessions based on their weighted factors (WF). Results showed that nutrient values were seed coat and location specific. MDA demonstrated that accessions with black variegated seed coat ranked 1st with a WF of (4.16), followed by brown 2nd (3.90), while the white coated seed of AYB with WF of (2.75) ranked lowest when the desirable nutrient values (high moisture, total protein contents, carbohydrate, low fat/lipid and better energy calorie nutrients) were pooled together amongst these accessions and location. Similarly, simple linear regression analysis showed that they were very highly significant at ($p < 0.001$) and positive with ($r^2 = 0.96$), ($r^2 = 0.86$) and ($r^2 = 0.97$) within these accessions at ($p < 0.447$) and ($r^2 = 0.17$), respectively. It implies that these accessions are potentially endowed with essential nutrients and could contribute to the daily nutritional requirement of these resource poor rural

and semi-rural dwellers in the country at this rapidly changing time. There is a need for purposeful policy programs on sustainable enlightenment on their nutritional benefits in order to promote their cultivation, consumption and commercialization. This will enhance the resilience and promote biohappiness in this country.

88 Fe^0-Based Filtration Systems for Universal Access to Safe Drinking Water

Chicgoua Noubactep

University of Göttingen

In the developing world, there is a permanent danger of an endemic of water borne diseases due to a lack of safe drinking water and poor sanitation. This deplorable scenario was captured by Kofi Annan as follows: “We shall not defeat any of the infectious diseases that plague the developing world until we have also won the battle for safe drinking water, sanitation...”. Over the last 40 years, an array of international programs have been designed for the alleviation of the global water and sanitation problems. The most recently completed program was the Millennium Development Goals (MDGs) which, in 1990, aimed at halving the proportion of people without safe water and sanitation by 31 December 2015. The MDGs were globally achieved but not in Sub Sahara Africa. The world is now working to achieve the Sustainable Development Goals (SDGs) adopted in September 2015 in Paris. Herein, countries from around the world identified goals and set targets to improve the human condition substantially by 2030. To achieve the SDGs within the remaining 14 years, existing knowledge should be effectively translated into practical solutions.
This oral presentation (candidate for a panel session) presents filtration systems based on metallic iron (Fe^0 filters) as an appropriate technology for promoting universal self-reliance in safe drinking water provision (and sanitation). The current state-of-the-art knowledge is presented and some options for the optimization of Fe^0 filters are discussed. The presentation will use commercial steel wool as a proxy of universally available Fe^0 materials.

89 Characteristics of Calabar Tidal Resource: Patterns and Relationship to Sustainable Clean Energy

Collins Nwaokocha[1], Mufutau A. Waheed[2], Abayomi T. Layeni[1], Olumuyiwa A. Lasode[3], Solomon O. Giwa[1]

[1] Olabisi Onabanjo University, Ibogun Campus, P. M. B. 5026, Ifo, Ogun State, Nigeria.
[2] Federal University of Agriculture, Abeokuta, Ogun State, Nigeria
[3] University of Ilorin, Ilorin, Kwara State, Nigeria.

The ability of tidal power to reliably contribute energy to electricity networks is directly related to the characteristics of the tidal resource. This research presents an investigation on the tidal energy potential of Calabar, Cross River State (Latitude 4.9667°N, Longitude 8.3167° E), a coastal region of Nigeria along the Atlantic Ocean. An analysis of the characteristics of the tidal power resource of Calabar in Southern Nigeria has been carried out, based on daily observed tidal height for a ten year period (2001–2010). Patterns of tide availability are presented, with data demonstrating distinct patterns of daily, monthly, and yearly variability – tides exhibited a sinusoidal trend over the ten-year period. The average yearly tidal height range of Calabar was 2.65–3.02 meters.

90 Food Waste in South Africa: Understanding the Magnitude, Water Footprint and Cost

Suzan Oelofse

CSIR

Globally, there are sufficient land and water resources to produce food over the next 50 years, but only if water for agriculture is better managed. Water is a critical and strategic natural resource in South Africa. It is essential for growth and development, for food production, as well as for the health and well-being of people and the environment

Low levels of variable rainfall associated with high evaporation rates, due to the hot climate, result in South Africa being the 30th driest country in the world. Irrigated agriculture is the largest single use of water in South Africa (60%) while livestock watering and nature conservation combined use about 2.5% water. Water has been identified as the major limiting factor to the growth of this sector. Agricultural production in South Africa has intensified over the past 20 years. Farms have increased irrigation, fuel, mechanization and genetically modified seed inputs in order to keep up with the demand for food supply. In addition, intensive farming practices also increase environmental risks due to dependence on synthetic fertilizers, pesticides and herbicides which reduces the long-term soil fertility and increases water pollution from agricultural run-off. Growth in household incomes, particularly in BRIC (Brazil, Russia, India and China) countries, is associated with a decline in consumption of starchy food staples and diversification of diet into fresh fruit and vegetables, dairy, meat and fish.

These products typically require more water than traditional staple foods, such as grains and tuber crops. A similar change in dietary requirements is already visible in South Africa. Development objectives, such as food security, improvement of the livelihoods of farmers, meeting the growing demand on non-food agricultural products and safeguarding environmental resilience can be facilitated by strategies that focus on reducing food losses between production and consumption. It is therefore imperative that we increase our knowledge and understanding of food waste in order to support economic development in developing countries. Food waste in South Africa is estimated at about 30% of the local, annual agricultural production.

By reducing food losses and wastage, water demand for agriculture could be reduced. This paper reports on research towards estimating the volumes of water lost as a result of food waste in South Africa.

91 Effect of Maintenance on Sustainability of Infrastructures

Ayodeji Emmanuel Oke[1], Clinton Ohis Aigbavboa[1], Kehinde Olumide Ologuntuyi[2]

[1] University of Johannesburg, South Africa
[2] Federal University of Technology Akure, Nigeria

The clamour for construction projects that are economically, socially and environmentally sustainable has been a centre of attention for researchers and practitioners in the construction industry. However, most of the efforts are geared towards pre-construction and the actual construction phase. As essential as these phases are to the implementation of the sustainable concept, less attention is paid to the importance of the period of performance and usage of the infrastructure where various forms of maintenance are essential. In this article, the effect of maintenance policies and procedures on sustainability of infrastructures was examined with a view to maintaining their performance through their usage lifespan. To achieve this, various maintenance practices available for construction projects were evaluated. More so, factors affecting maintenance of construction projects, and factors affecting sustainable development and the overall effect of infrastructure maintenance on sustainable development were also assessed.

Data were obtained through questionnaires administered to management staff of maintenance departments in various governmental and private organisations in south-west Nigeria. Despite the benefits associated with preventive maintenance, corrective maintenance policies are commonly used and this is due to misuse of infrastructure by occupants, use of poor quality materials and workmanship, natural deterioration due to age and environment as well as defects arising from specifications and design deficiencies. Using ANOVA, it was observed that the appropriate adoption of various forms of maintenance techniques have a significant effect on the sustainability of construction projects

Adequate and continuous maintenance will not only lower short-term costs, enhance energy savings and reduce assets' failure, but will also ensure safety of users or occupants. In view of this, governmental agencies and other stakeholders concerned with development and maintenance of construction

projects should improve on the awareness and enforcement of maintenance policies and plan for construction projects in order to enhance their sustainability.

92 Stormwater as a Resource for Water Supply and Urban Agriculture in Cape Town

John Okedi, Neil Philip Armitage, Kirsty Jane Carden

Department of Civil Engineering, University of Cape Town, South Africa

Conventional stormwater management generally involves the collection and swift conveyance of stormwater to the nearest watercourse solely to reduce risks posed by local flooding. Apart from negative environmental impacts associated with higher flood peaks and pollutant loads downstream that result in erosion and degraded ecosystems, this practice also results in lowered groundwater tables and the loss of a potential water resource from urban areas. With the growing global challenges of water scarcity, food insecurity, and environmental deterioration, alternative ways of managing stormwater should be considered.

The assessment of stormwater as a potential resource for water supply and urban agriculture is currently being carried out in the Zeekoe catchment in Cape Town, South Africa. The Zeekoe catchment covers approximately 89km^2 and encompasses a large diversity of land-uses including the airport, residential, commercial and industrial areas. Some 24km^2 falls within the Philippi Horticultural Area (PHA). The PHA contributes over 100,000 tons/year of fresh produce to Cape Town (about 50% of total vegetables). The Zeekoe catchment is drained by several constructed 'rivers', of which the most important is the Lotus River. Notably, it is located over one of the most productive parts of the Cape Flats Aquifer (CFA).

This study proposes adaptation of existing vleis (shallow lakes) and stormwater ponds within the catchment to function as collection, storage and infiltration cells to augment the water supply in Cape Town. The stormwater captured in the various open water bodies could be used for non-potable purposes such as urban agriculture, irrigation of residential gardens and public parks, toilet flushing or industrial uses such as cooling and cleaning. Groundwater from the CFA could additionally be treated to potable water standard and distributed through the existing reticulation system. The contribution from stormwater harvested in this manner has the potential to supply some 30% of local water demand.

93 Flood: A Threat to Sustainable City Development in South Western Parts of Nigeria

Akeem Olawale Olaniyi, Bashiru Adeniyi Adegbite

Osun State College of Education, PMB 5089, Ilesa, Osun State, Nigeria

Flood hazard has been identified as a major environmental threat to sustainable cities development especially in developing and transiting economies of the World despite her major investments in flood control infrastructures. Unfortunately, these infrastructures only offer short term solution to the menace of flood. Therefore, an alternative mitigation strategy that focuses on resilience through education and attitudinal change is required. Integrated Flood Control Mechanism as against the Engineering Approach offers alternative, effective and sustainable Flood Control/Mitigation Option in Nigeria because Integrated Flood Control Mechanism is a comprehensive and multi-faceted process that frames Flood Control around the social, financial and environmental capabilities of man thus integrating man into Flood Control System thus balancing land development with environmental variables.The aim of this study is to investigate the preference of Engineering Flood Control System over a more sustainable Integrated Flood Control Mechanism in South Western parts of Nigeria. Extensive literature review, expert consultations, In-depth Interview and Focus Group Discussions (FGD) with members of staff of Urban Flood Management Agencies and members of staff of the Ministry of Environment and households were conducted to elicit information on the capability of the Integrated Flood Control Mechanism as a Sustainable Flood Control Option over the Engineering Approach as being currently adopted in the South Western parts of Nigeria. Six hundred and twenty (620) questionnaires were administered in the South Western states mostly affected by flood. Of the six hundred and twenty (620) questionnaires administered, 535 were returned. The resulting data obtained were analyzed using relevant statistics.The results indicated that poor environmental education, poor land use planning and lack of sustainable environmental policy/proactive measures on the part of the government and the populace are the major factors militating against the adoption of Integrated Flood Control Mechanism in Nigeria. Therefore, these findings place heavy responsibility of environmental education on the shoulder of the responsible agencies in Nigeria.

94 Sustainable Resource Use through Water–Energy–Food Nexus Analysis

Olusola Oluwayemisi Ololade

University of the Free State

The complex relationship between water, energy and food (WEF) needs to be unravelled before security in the three sectors can be guaranteed. The relationship is exacerbated with the advent of climate change, specifically drought. This complexity is more evident in developing countries where utilisation of natural resources underpins development. If the resources are not used in an efficient way, it can have significant negative effects on the sustainability of either one or all of the three sectors. A negative impact on any of the WEF sectors will hinder the achievement of poverty reduction and social and economic growth, which is the target of the sustainable development goals (SDGs) proposed in 2015. Research in science and technology that cuts across the three pillars of sustainable development—environmental, social, and economic—can provide innovative holistic solutions that can meet the increasing needs of human beings in an equitable and sustainable manner. Case studies involving waste to energy which has little to no impact on the biophysical environment; and reduction of the water footprint in agricultural practices and energy production will strengthen the WEF nexus case. Possible scenarios of moving these innovative ideas from a small scale basis to being implemented on a bigger one are necessary for sustainable, efficient resource use in the future. The social and economic benefits of such projects in terms of job creation and reduction of human vulnerability to the potential impacts of climate change is important. The WEF nexus approach will help to integrate management and governance across different sectors on a varied scale, and influence policies that can be implemented holistically rather than in a silo.

95 Rethinking Biofuel Production from Agricultural Wastes in South Africa under Water Availability Constraints

Olusola Oluwayemisi Ololade[1], Bridget Tshikalange[1], Audrey Dale Levine[2]

[1] University of the Free State
[2] University of California, Santa Cruz

Production of methane, ethanol, and other biofuels from agricultural wastes is a tool for waste minimization that benefits the energy sector by yielding a fuel that potentially reduces greenhouse gas emissions. While the technology for biofuel production has advanced, challenges remain in terms of the amount of water that is needed, logistical connections to the end-user community, economic viability, workforce capacity, and sustainability. Within South Africa, biofuel sources include wastes from livestock production, maize and sugarcane, food crops, and organic materials from municipal wastes. The seasonality of waste production and the extent of co-mingling can affect the quality of the product, the extent to which post-processing is needed, and product marketability. Given the recent drought situation and the need to conserve water and arable land for food production, it is important to consider the competitive demands on water for food production and energy resources. The objective of this paper is to present a case-study of biofuel production from livestock waste in South Africa. The water source is a borehole with consistent flow and quality. The product biogas is available for on-farm uses including cooking. Additional clean-up such as the scrubbing of corrosive gases (e.g. hydrogen sulphide, carbon dioxide) would be needed to support other end-uses. Other potential resources that could be derived from the waste include nitrogen, phosphorus, and organic soil amendments. The gas yield per kg of waste is about 0.08 cubic meters with about 1.5 litres of water consumed per kg of waste. The case study will provide pilot-scale data from processing 100 kg of cattle manure under thermophilic conditions (32 °C). The results of the pilot-scale study highlight the importance of the up-front consideration of end-users, process start-up, operating requirements, process stability, costs, marketability, sustainability, and research needs in the context of the food-energy-water nexus.

96 Built Cultural Heritage as a Catalyst of Environmental Sustainability: A Pragmatic Paradigm for Anthropocene

Obafemi A.P Olukoya

Brandenburg Technical University

In the most succinct words, industrialisation came with its pros and cons. Ever since the advent of industrialisation, the greenhouse gas concentration in the anthroposphere has increased by 40% and the earth has been pushed to a post-Holocene era called Anthropocene, which is characterised by the extreme anthropocentricity of mankind. This has also been followed by global climate change which represents the greatest challenge to environmental sustainability today. However, an appraisal of contemporary research has proved that the greenhouse emissions are primarily from the various economic sectors today in Anthropocene. Buttressing the argument, the building sector is responsible for 23-40% of the global indirect greenhouse gas emission and 6.4% of the direct emissions. This has made the contemporary building sector one of the biggest contributors of greenhouse gases, which is responsible for global warming and the distortion of the geophysical equilibrium. Moreover, the emissions from the building sector are plausible, owing to the various non-environmentally friendly building materials employed by the contemporary building industry and absolute dependence on artificial heating, ventilation and air conditioning (HVAC).

Meanwhile, on the other hand are the built cultural heritages which have proved, for several millennia, to be energy efficient and have lower carbon footprints. This is owing to their passive design construct and employment of earth friendly building materials such as adobe, straw bale, wood, stones and many more. Sadly, despite the palpable abilities of the traditional building materials, it is surprising that they are not employed as a contribution to the greenhouse gas abatement in contemporary times. This is owing to a couple of reasons and misconceptions. On the one hand, the contemporary architectural movement, with its insatiable drive for hegemony and domination, has cultivated a tabula rasa approach which relegates the use of traditional building materials to being representative of conforming to poverty and primitivism. On the other

hand, the contemporary movement has defined traditional building materials as being anachronistic and incompatible with progress and it it thus assumed that contemporary solutions can address the contemporary challenges. These positions today in Anthropocene are not necessarily true and are in fact, deeply mistaken.

In light of these of these arguments, this paper makes a case for residential typology of built cultural heritage in the village of Louroujina in North Cyprus. The aim is to compare the energy consumption and carbon emission rate between the heritage building typologies and the modern buildings in the same climatic condition and energy supply. This is to prove that the much chanted dictum that built cultural heritage is more energy efficient and has a lower carbon footprint is not a mere abstraction but has its place with empirical realities. To validate these objectives, the research adopts a qualitative research approach. The primary data is collected via a computer based simulation procedure using Revit Architecture with a green studio plug in. This simulates the model of the two different buildings under the same climatic parameter. Conclusively, this research posits that, in light of the challenge presented by climate change on the four pillars of sustainability today, reinventing the traditional building material and learning from the design construct of the built cultural heritage is a pragmatic solution to the emissions produced by the building sector today in Anthropocene. In light of contemporary technological advancement, traditional materials can be reinvented in similarity, coherence and fullness of phenomena as an addendum to greenhouse gas abatement and to foster environmental sustainability.

97 Thermal Materials for CSP Plants: LCOE Evaluation for Performance Improvement Using Chilean Strategic Lithium Salts

Raul ORyan, Gustavo Caceres, Macarena Montané, Shahriyar Nasirov

Universidad Adolfo Ibañez

The improvement of solar thermal technologies in emerging economies, such as that of Chile, is particularly attractive because the country is endowed with one of the most consistently high solar potentials, lithium and copper reserves. In recent years, growing interests for lithium-based salts and copper foams in the application of thermal technologies could transform Chile´s lithium reserves into competitive energy produced in the region. This study reviews the technical advantages of using lithium-based salts—applied as heat storage media and heat transfer fluid—within tower and parabolic trough Concentrated Solar Power (CSP) plants, and presents a systematic evaluation of the costs of these alternatives based on two real plant data. The methodology applied is based on material database compilation of price and technical properties, selection of CSP plant and estimation of amount of required material, and an analysis of Levelized Cost of Electricity (LCOE). Results confirm that some lithium-based salts are effective in reducing the amount of required material and costs for the Thermal Energy Storage (TES) systems for both plant cases, with savings of up to 68% and 4.14% in tons of salts and LCOE, respectively.

98 Effects of 2010 Flood Event on Women in Cotonou City (Benin)

Blandine Ouikotan, Hans van der Kwast

UNESCO-IHE, Institute for Water Education

In 2010, Benin was among the top ten countries in the world hit by floods with respect to the percentage of victims; 9.3% of the total population was affected. In fact, Benin has experienced the worst flood which overwhelmed two-thirds of the country's municipalities, including Cotonou. This paper presents the effects of this flood on women in Cotonou City.

A total of 382 households were selected randomly from the flood prone areas of the city (30 districts) and 203 women were interviewed using a structured and pre-tested questionnaire. Data collected include, among others, the socio-economic profile of the interviewee, the type of residential dwelling, the characteristics of the structure of the buildings and contents, the characteristics (depth and duration) of the 2010 flood event, the cost of the small business disruption, the displacement of people from the flooded area and the effect of flood on their health.

The interviewed women consist of 78% food or cosmetics retailers, 12% craftswomen, 3% housewives, 2% salaried workers, 1% pensioners and 3% who did not declare their job. The flood depth in the rooms ranges from 0 to 150 cm and the flood duration lasts from 0 to 90 days.

A total of 74% of interviewed women have their workplace within the district. Consequently, the flood has affected their business. The cost of small business interruption ranges from €0 to €2020 during the flooding period.

More than 50% of women were displaced with their children while their husbands stayed in the houses in spite of the water because they were afraid of thieves. The flood event also affected the health of women and children. Among women who stayed in their houses during the flooding event, there were more cases of malaria, diarrhea, and cholera. Some isolated cases of death (one case) and heart attack (one case) were recorded.

99 Assessment of Consumers' Stated Preferences for Water and Carbon Footprint Sustainability Information: Insights from the Gauteng Province of South Africa

Enoch Owusu-Sekyere, Yondela Y. Mahlathi, Henry Jordaan

Department of Agricultural Economics, University of the Free State, Bloemfontein, South Africa

Given the current water scarcity situation and the impact of climate change on global warming in South Africa, there is a need for strategic policies that focus on consumers' changing behaviour and attitude towards sustainable food production and consumptions. The present paper has examined consumers' stated preferences for water and carbon footprint sustainability attributes in the northern part of Gauteng Province. Discrete choice experimental data and a random parameter logit model were employed in the study. We find that heterogeneity in preferences exists for water and carbon footprint sustainability attributes. The heterogeneity in preferences for water and carbon footprint sustainability attributes are significantly related to the individual's age, gender, income, and education as well as awareness of water scarcity and carbon emissions. The findings suggest that to communicate potential benefits and costs of water and carbon footprints effectively, policy-makers and interested groups should identify different heterogeneous consumer segments, and assess potentially simpler or more direct awareness or labelling methods that signal ecological sustainability as a new water scarcity and carbon emission campaign strategy.

100 Soil and Water Resources Deterioration and Preservation Perspectives in Three Intensively Cultivated Basins of Greece

Andreas Panagopoulos, Ioannis Vrouhakis, Andreas Ilias, Sofia Stathaki, Paschalis Dalambakis, Evangelos Hatzigiannakis, Aikaterini Karyoti, Iordanis Pappoutsoglou, Theodore Karyotis, George Arampatzis

Hellenic Agricultural Organisation-Soil and Water Resources Institute (former Land Reclamation Institute), Sindos Industrial Zone, 57400 Sindos, Greece

Greenhouse installations are a form of intensively cultivated agricultural land that is tightly linked to significant financial assets in several regions of Europe, especially in the European south. Depending on the degree of the adopted agricultural practices, the regional pedological characteristics and the hydrogeological structure of a basin, the effect of agricultural practices may have significant impacts on the soil and water resources. This work presents selected hydrochemical and soil quality findings from three key greenhouse cultivation basins in southern Greece, pointing out environmental issues that have been identified, on the basis of inorganic chemistry analyses and groundwater level measurements. Trifilia is an elongated basin located in SW Peloponnese, Tymbaki is a basin located in central southern Crete and Ierapetra is a very narrow basin in the eastern southern part of the island of Crete. A common characteristic of these coastal basins is the considerable extent of greenhouse cultivations, however discrete differences in their characteristics occur with respect to climatic conditions, soil properties, hydrogeological setup, overall land use and size. The main issues identified are high concentration of nutrients and elevated electric conductivities, whilst no alarming concentrations of heavy metals and trace elements were documented. In view of the EU requirements for sustainable use and preservation of the European natural resources, the main impacts expected in the future, as a result of the quality and quantity deterioration imposed due to the agricultural activities, are discussed. The climate change factor is also addressed in the context of the expected impacts, as temperature and precipitation variations are deemed to magnify the impacts. Furthermore, in the framework of the requirements of the new European Common Agricultural Policy (CAP) for greener

agriculture that safeguards the environmental values of groundwater systems, a suite of easy to implement interventions are proposed, aiming at alleviating the identified environmental issues. Proposed interventions are in the direction of minimizing the agricultural inputs by optimizing their use; managing available water resources in a more rational manner; reducing the energy consumed for agricultural production and the overall production costs, whilst safeguarding the cultivation yield and quality. It is proposed that, in this way, a balance between environment and production may be established, thus increasing the added value of the agricultural venture.

101 Does Coffee Producers' Transition to Cocoa Respond to a Sustainable Strategy to Cope with Climate Change? Mapping Probabilities for Crop Diversification in Nicaragua

Sonia Quiroga[1], Cristina Suarez[1], Juan Diego Solís[2], Pablo Martínez-Juárez[1]

[1] Department of Economics, University of Alcala
[2] Department of Economics, Universidad Nacional Autónoma de Nicaragua, León

Coffee producers in Mesoamerica are already facing some of the expected challenges arising from pressures derived by climate change, principally, lowered water supply. Some farmers have implemented strategies of adaptation based on crop diversification, with the introduction of cocoa being one of the main alternatives. The focus of this research is to analyse coffee producers' perceptions on changing from coffee to cocoa as an adaptation strategy. This research tries to find the factors that smallholders take into account when facing the decision of introducing cocoa. Here, we simulate the farmers' response to climate factors and water needs, also considering its relationship with humankind, specially through variables related to economic and social development. Farmers' perceptions were extracted via a specifically designed questionnaire applied to 219 small coffee producers in the departments of Esteli and Jinotega in Nicaragua. A Multivariate probit econometric model was estimated to analyse diversification through three simultaneous equations—for climatic, economic and social development drivers. Marginal effects of these drivers were calculated and used to simulate farmers' response to global change scenarios. Regional distribution of crop diversification probability was mapped considering different global change scenarios. The importance of climatic factors over the decision process is, as data shows, higher than social and economic issues. The environmental implications of this change, such as deforestation, have also been discussed.

102 Effectiveness of Biodiversity Offset Strategies in South Africa: Current Perceptions and Views in the Mining Industry

Isaac Tebogo Rampedi, Edwynn Walter Louw, Jayne Margaret Rogerson

University of Johannesburg, Department of Geography, Environmental Management and Energy Studies

South Africa has been recognised as the third most biologically diverse country in the world and has three globally recognised biodiversity hotspots. However, the concept of biodiversity offsets is relatively new and there are only generic methods which are ill-suited to determine appropriate biodiversity offsets in the South African context. In South Africa, the rationale for biodiversity offsets is based on its global uniqueness and the role that natural ecosystems play in supporting socio-economic development with crucial ecosystem goods and services. Be that as it may, land-intensive development poses a significant threat to the remaining biodiversity; hence South African policies are increasingly prioritised towards the conservation of biodiversity and important ecosystem services. With increased land use changes, the need has developed for tackling unavoidable and residual impacts on biodiversity. This study was aimed at comparing the current South African biodiversity offset approach to that of offset banking and no net-loss or net-gain principles, as a feasible and beneficial alternative. To this end, a structured interview process was conducted to determine current understanding and perceptions relating to biodiversity offsets, biodiversity offset guidelines and regulations, offset banking, relevant experiences as well as perceptions relevant to the mining sector. The results have indicated the extent to which biodiversity offset practices are understood as well as the rationale for biodiversity offset banking in South Africa. The overall impetus of offset banking in the South African situation would require competent authorities to set up bank funds in order to purchase conservation credits commensurate with the impact of land-use activities.

103 Assessing the Sustainability of Small Scale Renewable Energy Projects in South Africa by Means of EIA Quality Review

Isaac Tebogo Rampedi[1, 2], Daniel Sarel Boshoff[1, 2], Olusola Oluwayemisi Ololade[3]

[1] University of Johannesburg, Department of Geography, Environmental Management and Energy Studies
[2] University of Johannesburg, Department of Geography, Environmental Management and Energy Studies
[3] University of the Free State, Centre for Environmental Management

The revised 2010 Environmental Impact Assessment (EIA) Regulations in South Africa sought to improve environmental impact assessment (EIA) procedures as well as criteria for the environmental authorisation of listed development proposals, the goal being to ensure their environmental sustainability. An environmental impact assessment report (EIAR) plays a crucial role in this context as it should communicate all the findings associated with such assessments to relevant stakeholders – including environmental authorities – for decision-making purposes. However, the quality of EIARs does not always satisfy specified criteria, thus compromising the effectiveness of EIA. In South Africa, the assessment of EIAR quality has mostly been focused on full EIAs to the exclusion of reports originating from basic EIA assessments. Basic EIA assessments are specifically conducted for small scale projects and proposed activities in specific geographic regions. To address this shortcoming, the quality of 25 solar energy EIARs were reviewed, making use of an adapted Lee-Colley review package. Based on this review, 68% of EIARs were satisfactorily conducted while 80% of the overall scores were regarded as borderline grades. Most descriptive assessment tasks were conducted relatively well whereas the more complex assessment tasks such as determining impact significance, alternatives, mitigation planning, and the communication of findings were executed unsatisfactorily. Inevitably, there were more weaknesses than areas of strengths, which reflect negatively on the sustainability of the proposed renewable energy projects.

To overcome these challenges, it is recommended that prior to the submission of EIARs, such documents must be subjected to independent specialist review so that their weaknesses can be augmented while their strengths can be enhanced further.

104 Small-Scale Farmers' Adaptation to the Impacts of Climate Change: A Case Study of Sagole Women Farmers in Limpopo Province, South Africa

Agnes Rankoana

Department of Sociology and Anthropology; University of Limpopo, Private Bag X1106, Sovenga 0727, South Africa

Sejabaledi A. Rankoana Professor and Head of Department of Sociology & Anthropology, University of Limpopo, Private Bag x 1106, Sovenga 0727, South Africa. Office Tel: +27 (0) 152682179. Mobile: +27 (0) 724431321. Email: sejabaledi.rankoana@ul.ac.za. Abstract The present study explored challenges faced by women subsistence farmers in a rural community in Limpopo Province, South Africa. The study is motivated by observations from the literature that the impacts of climate change are threatening food security measures in rural communities. Focus group discussions with 45 women farmers revealed that the women produce subsistence crops in a community garden provided by the chief-in-council. The challenge experienced by the women is lack of support from agricultural extension officers to maintain their production. Unpredictable rainfall and changing environmental conditions such as increased temperature, thunders, wind and persistent drought are major challenges. But the women are resisting the impact of these challenges on their production. Sustainable production is accomplished through growing of short-season crops, mulching, use of spring water for irrigation and soil fertilization by kraal and poultry manure.

105 Mid-Size Urban Areas, Between Local and Global Issues: When the Will for a Sustainable Mobility Turn Faces Local Issues

Bénédicte Rey, Fabienne Picard

UTBM

Reducing greenhouse gas and pollution is an admitted priority nowadays, including in the mobility field. Most large cities have begun to take concrete actions towards making mobility more sustainable. For smaller cities with lower density populations, the issue is harder to deal with. Among these smaller cities, mid-size urban areas represent a specific challenge in themselves. There are characterized by significant commuting distances, while having less traffic issues and less strain on their transport infrastructures.

Based on archive analysis interviews with elected officials and a focus group with citizens, this project explores such a mid-size area: the Belfort Montbéliard Héricourt Delle urban area, located in France, representing more than 300 000 inhabitants.

As an industrial intensive area, transportation and air pollution issues are particularly significant.

For many years now, the different cities composing this larger urban area work together in order to form a united institutional area. The goal for them is to become a significant actor on a national scale (France) and even larger (Switzerland…). Significant from an economic point of view, but also because it could represent an attractive area to work and live, thanks to its culture and leisure opportunities.

With this in mind and considering the area's industrial context (flow of goods and people), the geographic proximity of the cities and the strong car culture - in part due to the presence of local car manufacturer (PSA Peugeot-Citroën) and his suppliers -, mobility has become an important issue in the area. The question of mobility is important for local industries, but also for people who often live and work in different cities within the area.

Different mobility projects have been considered in the past years, especially in the Belfort metropolitan area and in the Montbéliard metropolitan area. Presented as innovative, these projects have introduced alternatives to the individually owned car, such as self-service car services. They also have

introduced the idea of regulating car traffic in a way which will favor public transport, particularly via dedicated bus lanes, in order to supply specific cities with more viable alternatives to the car.

Even though issues of transport and sustainable mobility have been publically addressed by local politicians, not all of these projects were effectively implemented in the different cities. But more importantly, political action on a larger scale has barely emerged, questioning the actual importance that has been given to these issues.

In our presentation we will discuss the conditions required for sustainable mobility policies and projects to be implemented by decision makers in areas like Belfort-Montbeliard, where traffic and local air pollution are not always perceived as major issues. We will focus on governance issues during the past decades. We will show how old rivalries and identity questions can hinder mobility policy making. We will also point out the successive visions underlying the projects adopted in each city; the political rotations and the varying importance given to sustainability further hindering a long-term response to mobility issues.

106 Economics of Dryland No-Till Wheat Supports Climate Change Adaptation

Henri Rueff

University of Basel

A large part of the world's wheat is produced in drylands which are expected to expand, with more frequent droughts, and fewer but heavier rainfalls. Maintaining the production of wheat, climate change notwithstanding, is hence a major global food security challenge. No-till (NT) enhances soil moisture and organic components and is therefore a sustainable land management practice suitable to drylands. While NT benefits have been documented, the economics of dryland NT, incorporating price and weather uncertainties, remains unknown. Yet it is essential to predict how NT feasibility performs under increasingly erratic conditions. Using 30 years of daily weather data and a soil moisture indicator to predict NT wheat yields, this Monte Carlo simulation (10,000 iterations) shows that from a production function perspective and considering all other components being equal, rain-fed NT wheat is feasible until the semiarid–arid boundary while conventional tillage (CT) requires state support to be cultivated at the same aridity level. In other words, risk-neutral wheat farmers under conditions similar to those in Israel (one rainy season in winter) will find in NT wheat farming a form of agriculture management suitable for highly uncertain environments. With climate change induced warming, increasing dry spells, and heavier but decreasing rainfalls, dryland farmers will need more inputs and state support for CT and less so for NT wheat. Moreover, soil conservation collateral benefits and climate change mitigation are likely to further support dryland farmers. NT wheat presents significant climate smart agriculture features, which are better adapted to the uncertainty of drylands.

107 LEAP-FAO Progress on Water Footprints and Water Impact Quantification

Valentina Russo

Chemical Engineering Department – EBE Faculty – University of Cape Town, 7701 – Rondebosch, South Africa

Water is an essential input for feed production and livestock supply chains. In several geographical areas, water is an increasingly scarce resource whose availability varies widely over temporal and spatial scales. In addition, other challenges, such as climate change and increasing competition with other users, are exacerbating water scarcity. Efficient management of this resource is essential to ensure food security and viability of livestock supply chains.LEAP (Livestock Environmental Assessment and Performance) Partnership is a multi-stakeholder initiative launched in July 2012 and currently hosted by the FAO (Food and Agriculture Organization of the United Nation). LEAP was created under the umbrella of the FAO's Strategic Programme 2 with the goal to make agriculture, forestry and fishery more sustainable. The FAO-LEAP Water technical advisory group (TAG) aims to build a global consensus on Water Footprinting (WF) and to develop guidelines to support water management solutions for the environmental performance of the livestock sector. The activity will result in LEAP guidelines as well as case studies at different scales of assessment: farm and field, catchment and water management areas, regional (agro-climatic zones) and global levels. Livestock sectors of interest are small and large ruminants, poultry and pork supply chainsTwo standards are currently used in WF assessment (WFA): the one spearheaded by the Water Footprint Network, conceptualised and developed by A.Y. Hoekstra—more focused on water efficiency; the other based on the principles of LCA and standardised in the ISO 14046:2014 aims at quantifying water scarcity and water degradation. The methods are said to be complementary (Boulay, et al., 2013). Case studies on South African commercial beef (completed) and pork (on-going) supply chains will help to shed light on WFA in terms of water stress and water efficiency.

Reference

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108 Building an Interdisciplinary Framework for Strong Sustainable Educational Design: A System-Of-Systems View

Niclas Sandström[1], Veijo Hytti[2]

[1] Department of Teacher Education, Faculty of Behavioural Sciences, University of Helsinki, Finland
[2] School of Energy Systems, Lappeenranta University of Technology, Finland

In recent years, a lot of international attention and concern have been paid to both ecological and economical and social sustainability. Often, the dimensions of sustainability revolve around economy (businesses' societal responsibility) and ecology. However, there is still scarce knowledge regarding ***educational*** measures, design and development in a holistic view to strong sustainability (Sandström & Hytti, 2016). In our paper, we aim at combining strong sustainability thinking with considerations on education's key role in sustainable development both on a grassroots level and theoretically.

In our framework, we work on Mode II transdisciplinarity (Scholz & Steiner, 2015): the theoretical framework leads to a concrete sustainable education design pilot in **Namibia**. The pilot combines education expertise and stakeholder knowledge. We use a matrix where the [economical, ecological, social] are coupled with the [cultural, digital, physical] attributes and variables related to them (e.g., literacy rate; government expenditure on education; solar radiation), resulting in a 9-fold table. The pilot is a transdisciplinary effort between stakeholders and several universities. It links educational design, sustainable and adjustable construction (locally sourced sustainable materials), renewable energy (mainly solar), a digital learning platform and training in social and emotional skills.

We hold the Brundtland Commission definition for sustainability as a starting point, argumenting however for additional dimensions from the sustainable educational framework on various levels, e.g:

- informing theory through pilots and educational design;
- improving on opportunity distribution (superseding the problematics of parent-to-children educational level) & fostering inter-generational learning;

- making schools and educational facilities self-sustained centres of the community and of lifelong learning, resulting in locally sourced development even in remote areas.

The process is iterative: starting from interdisciplinary foundations, concrete design action produces new data and insights that will again inform the framework on all its dimensions. Our aim is not only to educate sustainability, but through sustainable educational design, to transform society and thinking so that we ***do*** sustainability.

109 The SustUrbanFoods Project: Challenges in Accounting for the Sustainability of Complex Urban Food Systems

Esther Sanyé-Mengual, Francesco Orsini, Giorgio Prosdocimi Gianquinto

Research Centre on Urban Environment for Agriculture and Biodiversity (RESCUE-AB), Department of Agricultural Sciences (Dipsa), Alma Mater Studorium – Università di Bologna (UNIBO), Bologna (Italy)

Forms and number of urban food systems (UFS) are growing in the last decade towards urban sustainability. Due the social gaps and environmental quality constrains of urban environments, the activity of growing food is commonly combined with other related activities (e.g., social improvement, biodiversity management, local development) thereby contributing to urban sustainability as a tridimensional concept: environment, society and economy. Therefore, UFS become complex productive landscapes, challenging current sustainability metrics. A limited number of studies have approached the quantification of the sustainability performance of urban food activities. In particular, these studies lack of a three-bottom perspective that integrates the environmental, economic and social dimensions.

The SustUrbanFoods project "Integrated sustainability assessment of social and technological innovations towards urban food systems" is a Marie Skolodowska-Curie Action (MSCA) that focuses on overcoming such challenges. The goal is to develop an interdisciplinary methodological framework to quantify the sustainability of UFS, providing with tools and data for supporting policies and decisions on sustainable UFS towards local and green economies.

The methodological design of SustUrbanFoods will follow a participatory process where stakeholders of UFS will be engaged in discussion on what aspects are determinant in sustainability and how this elements can be quantified in an understandable way to be employed by policy-makers and the general public. The integration of life cycle assessment and ecosystem services accounting methods is the basis of the SustUrbanFoods' scheme to analyze the impacts and benefits of urban food systems on the three dimensions of sustainability.

This contribution will present the details of the project and the preliminary results of the participatory process during the methodological design,

highlighting the perceptions and discussion held by the different stakeholders involved in urban food systems. Furthermore, the suitability of employing life cycle assessment and ecosystem services will be evaluated with stakeholders.

110 The Nexus between Sustainable and Value Investing

Florian Schaller, Lars Kaiser

University of Liechtenstein

This research project can generally be assigned to the field of fundamental investment management and combines non-financial issues in the form of environmental, social, and governance (ESG) factors with the classical financially-based fundamental analysis to derive investment decisions. Specifically, we are interested in whether value- and sustainability- returns show consistent patterns across diverse markets and whether there are common factor structures among them.

We take the financial return perspective by examining the value and sustainability premium in international stock returns, as well as analysing the existence of a common factor structure among value- and sustainable-returns. In this respect, we build on the methodology applied by Asness, Moskowitz and Pedersen (2013), who conduct a similar analysis by considering commonalities between value and momentum returns.

We contribute to a field of research experiencing increased attention over the past years, but reported findings are inconsistent due to a narrow focus on single countries, industries or aggregated ESG ratings by many papers. Thus, this papers provides a large scale analysis based on an international dataset covering a time period of 14 years and allowing for subsamples along the dimensions of countries, regions, industries and ESG sub-categories. Furthermore, it is, to our knowledge, the first empirical study directly examining the commonalities between value and sustainable equity returns, yielding valuable insights for investors, portfolio managers and corporates alike.

111 Review of Sustainability Indicators at the Level of the European Union and the National and Regional Level of the Federal Republic of Germany

Dorothea Schostok, Oscar Reutter, Manfred Fischedick

Wuppertal Institute for Climate, Environment and Energy, Germany

According to the good governance criteria for sustainable development, a sustainability strategy has to include a target system, as well as monitoring and an evaluation [1]. The formulation of quantified and terminated objectives in the form of indicators is an important instrument for the binding effect of the strategy on the one hand and for advanced control and monitoring on the other hand [2]. Indicators are an essential instrument for sustainable analyses and political decision-making [3]. For the development of a sustainability strategy at a national or regional governmental level, it is rational and useful to learn from existing strategies.

This paper focuses on existing indicators from sustainability strategies, respectively indicators and progress reports, used in the European Union, the Federal Republic of Germany, and their federal states. In total 342 indicators were identified in the 16 analysed sustainability documents. The 342 identified indicators were examined with regard to terminated and quantified target statements, differences in the definitions, and operationalization of the indicators, as well as possible interactions and interfaces that arise in the indicators to other fields or cross-cutting issues. The wide range of identified indicators shows the variety and heterogeneous use of indicator systems in the analysed sustainability documents. This substantiates a restricted comparability between the indicators and creates a sound basis for further considerations regarding the development of an indicator-system at the same time.

The review of the identified indicators shows that a selection of appropriate indicators must be taken, which meets the specifics of a nation or a region, ensure a proper mapping of the field of action or cross-cutting issues, and correspond to the following key points: relevance, predictability, and data availability, quality criteria, terminated, and quantified objectives: SMART criteria, robustness, interactions, political communicability, vertical integration, and coherence. Furthermore, the review shows that an indicator is not necessarily a good indicator of a field or cross-cutting issue

just because it is used in a sustainability strategy. Because of this, we suggest extending the scope of existing sustainability indicators. The paper gives an overview of 22 innovative and alternative indicators and indices, in particular for the social and economic measurement of a sustainable development. Additionally, 69 field of action and cross-cutting issue specific indicators are suggested to be tested in further research.
In the presentation, the central differences and similarities of the 342 identified indicators will be presented in correspondence to the 17 SDGs and assorted indicators will be discussed in depth.
The paper presents the approach, results, and lessons learnt within the ongoing scientific project "Sustainability Strategy for North Rhine-Westphalia (NRW) – Conceptual Analyses and Considerations on Designing a Sustainability Strategy NRW from the Science Perspective" (2013-2017). It accompanies the development of the sustainability strategy for the federal state of NRW, which is envisaged to be adopted in 2016. Project Website: http://wupperinst.org/en/p/wi/p/s/pd/469/

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112 Are Citation Impact Indicators of Research Performance of Any Use in the Developing Countries of Sub-Saharan Africa?

Desiree Sehlapelo

Science, Technology and Innovation

There has been good development in most African countries, one such recent example being the commitment to human capability and skills development which is deeper and broader than ever before. Even though knowledge and skill development are the overarching pillar for the success of the 2030 Agenda for Sustainable Development, there is a less considerable amount written on the citation impact indicators of research performance in developing countries of the sub-Saharan countries. Developing countries and particularly Sub-Saharan countries lie at the margins of scientific publication output with limited access to scientific networks that could impact the research performances. As such, citation impact indicators plays an important role for sustainable development as a way to identify emerging risks and opportunities, inform and provide evidence-based targets as well as progressing towards the achievements of the set targets.

This paper would like to contextualise the situation in which Sub-Saharan Africa finds itself, with low research outputs leading to a vicious cycle. It will further explore the reasons behind low citation impact indicators for research performance in developing countries with a specific focus on Sub-Saharan Africa. Following independence, African political regimes tended to evolve in three stages: consolidation of authoritarian rule by the mid-1970s, crisis management under authoritarian rule to the late 1980s and an outburst of democratisation starting in 1990. There are a number of challenges posed by the Sustainable Development Goals (SDG's), whereby close collaboration between various stakeholders, including the scientific community through their research outputs and policy makers, could enhance transformative support towards an integrated policy and planning process as well as monitoring sustainability.

113 The Urban End of Food Value Chains in Secondary African Cities

Lesley Sibanda, Harro von Blottnitz

UCT

Rapid urbanization, continued population growth, resource depletion and climate change and variability are thought to pose significant threats to food security, especially in poor communities. The nature of these threats in African food systems have been well-studied in terms of rural production as well as consumption and security in major cities. However, not much is known about food production, processing, distribution and consumption behaviors in secondary African cities.

This study evaluates key food value chains in Kisumu (Kenya), Kitwe (Zambia) and Epworth (Zimbabwe) from a life cycle perspective. The aim is to identify the stages within the food systems with significant environmental and social impacts and therefore describe the environmental and social externalities that exist and undermine public health and development in these cities. The work consisted of a review of published literature as well as fieldwork undertaken in each secondary city. During the fieldwork, various formal and informal food markets were visited and data was collected through personal observation, focus group discussions, informal interviews with traders, and formal interviews with relevant stakeholders.

The analysis revealed very rich and diverse food supply chains in both Kisumu and Kitwe, with less variety and resilience apparent in Epworth. Food supply sources range from local urban agriculture via regional supply and cross-border African trade to global supply chains. Prominent negative impacts of food provisioning in the studied cities include air pollution from thermal food preparation, poor hygiene in markets and poor to absent waste management. The research findings suggest significant needs opportunities for cleaner technology investments into the urban stages of African food systems. There is also scope for inter-African exchanges on practices that can improve resource-efficiency.

114 Ecopreneurship and Green Product Initiative as a Panacea for Sustainable Green Trade Development in Nigeria

Mayowa Oludele Solaja

Department of Sociology, Olabisi Onabanjo University, Ago-Iwoye, Nigeria

Modern societies exist with copious environmental problems which affect the well-being of people, business organization and the structure of trade development in both northern and southern regions of the world. One such sustainable approach to address these environmental problems is the promotion of green trade through ecopreneurship and green product initiatives. This paper therefore examines ecopreneurship and green product initiatives as a panacea for sustainable green trade development in Nigeria. It explains the exclusive roles of ecopreneurship education and green product creativity in the rising trend of green trade in the current global market. This paper examines the availability of resources and policies required to promote green trade in Nigeria. It documents the numerous benefits associated with ecopreneurship and how these benefits can translate into an anticipated sustainable environment in Nigeria and beyond. It also explains the challenges and multi-level intersection of ecopreneurship and green product initiatives within the context of green trade development with case studies from African countries such as Morocco, Kenya, Rwanda and South Africa. Theoretically, this paper adopts Schumpeter's theory of entrepreneurship and Ecological modernization theory as a framework to stress the importance of ecopreneurship and green product initiatives in the context of green trade development and environmental sustainability. This paper is explanatory with the use of secondary data sourced from current and relevant academic publications and reports. Findings from the paper serve as indicators and pointers to government, researchers, academics and other stakeholders to promote, engage and invest in ecopreneurship and green product initiatives as the lens to locate the path to a more sustainable future.

115 Sustainable Communities: Communities and Natural Resource Management

Michael Solomon

Minerals to Metals Signature Theme, department of Chemical Engineering, University of Cape Town

Over the last decade community activism and resource nationalism has featured prominently as one of the highest risk factors facing the mining and extractive industries. This rising tide of community protest is premised on demands for a more equitable distribution of benefit from the exploitation of natural resources on land that currently belongs or once belonged to them. It is an exceptionally complex arena the juxtaposes international law on native title, irrevocable and irreversible alienation of land into freehold title over centuries of colonisation and diverse national legislation on minerals title and the ownership of natural resources.

From a perspective of social and economic history, ownership of natural resources by communities is highly problematic. The social and demographic disruptions brought about by colonisation, the disintegration of traditional structures and leadership within communities, the tension between traditional leadership and contemporary politics and the nature of modern capitalist investment and economy are all factors that impinge on the perceptions that underpin the concept of 'social licence' and ultimately the pragmatic resolution of these issues.

Nevertheless, there are examples where indigenous communities have managed to navigate these complexities and have embraced different models of resource management and the effective distribution of benefits. The Royal Bafokeng Nation is undoubtedly the most high profile and one of the most interesting of these. Located on the Platinum Belt of the Bushveld Igneous Complex in South Africa, the Bafokeng are often billed as one of the wealthiest communities in the world. The provenance of their wealth and the business models and administrative systems that they employ make for a fascinating if controversial study.

This session will briefly review the Bafokeng model and compare it to other models of community management of resources and devolution of benefit. Of the most significant of these is that of the Innuit Communities in the North West Territories in Canada, which have adopted a similarly successful

commercial approach to the management of their resources, but a very different business model. Closer to home, the comparison between the Bafokeng and their neighbouring communities in the platinum belt, inter alia the Bakubung, Bakgatla and Bapo communities is equally relevant. These are communities within the same economic, social, cultural and political paradigm as the Bafokeng, but where leadership starkly differentiates the degree of benefit reporting to their constituencies.

The discussion will focus on the concept of community benefit, its legitimacy and a comparative critique of sustainability of the various community management models.

116 The Economics of Landscape Restoration: Benefits of Controlling Bush Encroachment and Invasive Plant Species in South Africa

William Stafford[1], James Blignaut[2], Christo Marais[3]

[1] Council for Scientific and Industrial Research (CSIR)
[2] University of Pretoria
[3] Department Environmental Affairs

Bush encroachment and alien plant invasions alter the composition and/or balance of species in natural ecosystems and thereby reduce the ability to deliver a suite of ecosystem services underpinning economic productivity and sustainable development. Landscape restoration with the appropriate control and management of bush encroachment and alien plant invasions can restore biodiversity, land productivity and water resources, while providing timber and non-timber products to society. In order to understand the economics of land impacted by bush encroachment and alien plant invasions, we estimated the value of a selected number of ecosystem services over a twenty-five year time period of a landscape restoration programme. Water availability, grazing capacity, terrestrial carbon, and biomass utilisation for wood products (timber, wood fuels and electricity) were the key provisioning and regulating ecosystem services that were valued as part of landscape restoration.. The estimated value of ecosystem services was US$6.6 billion from the restoration of alien plant invasions and US$2.1 billion for restoration of bush encroachment . The most valued ecosystem service benefit assessed was water, followed by timber products, wood-fuels and biomass-to-electricity, and then grazing. This partial economic analysis did not value a range of other ecosystem service benefits and therefore is likely to be an underestimate of the true value of ecosystem services delivered following land restoration. Nonetheless, it clearly illustrates that the management of invasive alien plants and bush encroachment can deliver significant ecosystem services benefits whose value outweighs the cost of management and control- estimated to be US$1.9 billion to clear alien plant invasions and S$1.1 billion to control bush encroachment. The clearing alien plant invasions and bush encroachment also has notable social and economic benefits; since it is labour-intensive and creates numerous employment opportunities

to support rural livelihoods and stimulate more inclusive socio-economic development. The effective implementation of these landscape restoration programmes will require public-private partnerships, long term investments, planning, strategy and policy coherence, in order to coordinate action and effectively achieve a more prosperous and equitable society living in harmony with natural resources.

117 Green Technologies for Food Production: The Mitigation Potential in Cereal, Fruit and Dairy Value Chains

Matthias Stucki, Deborah Scharfy

Zurich University of Applied Sciences

Agriculture is among the largest contributors to greenhouse gas emissions. Emerging countries like South Africa are global producers of main agricultural products. Also, their demand for animal products is growing rapidly and crops are commonly irrigated with fossil fuels. Consequently, the mitigation potential of environmental burdens through implementation of clean technologies is notable. Therefore, a joint research project of the University of Cape Town and the Zurich University of Applied Sciences aimed to quantify the mitigation of environmental impacts through clean technologies in the South African production of maize, fruits and dairy products.Results showed that electricity consumption for irrigation of maize production, the South Africa's most important staple food, is one of the major environmental hotspots. By switching to photovoltaic electricity supply, the global warming potential of maize production under irrigation can be reduced by 33 %. Reckoning the South African maize production area under irrigation, 237'000 t CO_2 could be saved per year, if electricity for irrigation needs would be produced by solar panels.The environmental assessment of fruit value chains highlighted that electricity consumption throughout the food production and processing contributes significantly to the environmental impact. At farm-level, electricity and infrastructure demand for irrigation is associated with the highest impact in terms of greenhouse gas emissions. The implementation of variable speed drives in water pumps, leads to a reduced global warming potential and cumulative energy demand of 8% for the pome fruit.
Amongst dairy products, raw milk production revealed to be the key factor when assessing environmental impacts. Average greenhouse gas emissions amount to 1.6 kg CO_2-eq per kg raw milk, whereof direct methane emissions contribute most to its carbon footprint. In addition to measures to reduce emissions from enteric fermentation, efforts to mitigate the environmental burden related to the production of concentrated feed are crucial.

118 The Transition to Sustainability as Value Transition—the Role of Universities

Carolina Suransky[1], Henk Antonius Manschot[2]

[1] Dept. Globalization – and Dialogue Studies, University of Humanistic Studies, Utrecht, The Netherlands and Institute for Reconciliation and Social Justice, University of the Free State, South Africa.
[2] University of Humanistic Studies, Utrecht, The Netherlands (emirtus Professor and former Vice Chancellor)

There is a new global awareness of the need to make sustainability the key concern of the 21st century. The ways in which humans aim to increase the quality of their lives will have to become inextricably connected with the wellbeing of the earth. This is a difficult shift and, due to global inequalities, there are also major differences in how local communities can make a transition to sustainability possible.
In as much as we need to have all on board in realms such as business, technology, politics and policy-making, it is vital to realize that the required transition will be driven by a value transition. To enhance worldwide support for change, we need to focus on how people could rethink and experience the values which guide them personally and professionally. This dimension also becomes central in the domain of education and has implications for how we orient students and organise the curriculum at all levels. This paper focuses in particular on experiences at university level.
In their response to climate change, students, like other people, often fall into five broad categories. The first one, popular in western countries, is fragmented action, meaning that they may take one or two 'green' initiatives in their personal lives, but leave their lifestyle and study otherwise unaffected. The second category is apathy, leading to inactive or indifferent responses. Here they think: the global problem is too big, it is not my fault, I can do nothing to really make a change (Hulme, 2009; Dodds, 2011). The third category involves active denial or scepticism which makes people dispute the consequences of human impact on the earth in pursuit of their industrial, political and ideological interests. Fourthly, there are those who do not deny climate change, but feel morally justified to do nothing because the problems were caused by highly industrialized nations in which they do not live. They argue that global inequalities and injustices will first need to

be addressed politically. Finally, there are those who have assumed a form of disconnectedness. They experience a gap between what they know and what they feel. Confronted with environmental crises they experience that their education has not prepared them for new problems that confront them. (Latour, 2011, 2015).

We believe that universities should offer platforms where students can reflect on their viewpoints and learn to connect core values of sustainability to their academic and professional orientations and choices.

On the basis of experiences in our annual Summer School on Pluralism and Social Change where we bring together graduate students and activists from across the world, this paper focuses on how universities could rethink how they link values and knowledge when educating students. The paper foregrounds issues and examples which stem from this Summer School and point to (1) raising new awareness of the relation between the global and the local, (2) interdisciplinary thinking and (3) valuable interaction between academic and practice-based knowledge.

119 Sustainable Development and Water–Energy–Food Nexus: MuSIASEM vs BIPLOT Perspectives

Nathalia Diazibeth Tejedor-Flores[1,2]

[1] PhD studend, Department of Statistics, University of Salamanca, Salamanca, Spain
[2] Environmental engineer, Technological University of Panama, Panama

Over the last few years there has been an increase in academic interest in the nexus between food, energy, water, land use and population. This interest is not only because of the individual growing importance of each of the elements, but also a result of recognition, from those working in sustainability science, that it is impossible to analyse the different elements of the nexus one at the time, as if they were independent from each other. Indeed, the very idea and description of interface of food, energy, water, land and population as a "**Nexus**" emphasizes the need for an integrated analysis and understanding. The Food and Agriculture Organization of the United Nations (FAO) concept of **Water–Energy–Food Nexus** explicitly addresses interactions and feedback between human and natural systems. It focuses on the resource base, including both biophysical and socio-economic resources, on which we depend to achieve social, environmental and economic goals pertaining to water, energy and food. To understand how the **Water–Energy–Food Nexus** works, we used the Multi-Scale Integrated Analysis of Societal and Ecosystem Metabolism (**MuSIASEM**) approach. The **MuSIASEM** is an innovative approach to accounting that integrates quantitative information generated by distinct types of conventional models based on different dimensions and scales of analysis. It builds on several innovative concepts derived from Bioeconomics and Complex Systems Theory, such as the flow-fund model, multi-purpose grammars and impredicative loop analysis. The application of these concepts allows the simultaneous use of technical, economic, social, demographic, and ecological variables in the analysis of the metabolic pattern of modern societies, even if these variables are defined within different dimensions of analysis and non-equivalent descriptive domains and refer to different hierarchical levels and scales. The main objective of this work is to enrich the **MuSIASEM** approach with information from multivariate methods in order to improve the efficiency of existing models of sustainability. The **BIPLOT** method permits the joint plotting, in a reduced

dimension of the rows (individuals) and columns (variables) of a multivariate data matrix. The **HJ-Biplot** achieves an optimum quality of representation both for the individuals (rows) and the variables (columns); additionally, its plots both of them on the same reference system. This representation is intimately related to principal component analysis in the sense that the matrices of variance and covariance are plotted on the two planes that absorb the greatest part of the variability. Finally we proceeded to the implementation of technical inspection and classification of multivariate data using **Cluster Analysis**; the goal of this technique is that the individuals within a group be similar (or related) to one another and different from (or unrelated to) the individuals in other groups. The greater the similarity (or homogeneity) within a group and the greater the difference between groups, the better or more distinct the clustering. We found, in the case study of Ecuador, that the overall score of energy, capital and labour are better than country reference average, with the exception of the sustainability in the food (in this case, it could be that the land use or water use is not efficient). We conclude that the **Water–Energy–Food Nexus** considered different dimensions of water, energy and food equally, allowing the function of each economic sector to determine the labour productivity and water consumption of a country.

How my work makes a contribution to the WEF-nexus:

The multivariate statistical analysis performed in this abstract helps us to better understand the complex and dynamic interrelationships between water, energy and food, so that we can use and manage our limited resources sustainably. This two approaches (MuSIASEM and HJ-Biplot) make an innovate contribution to the WEF-nexus.

120 Sustainable Mobility Transitions and Policy: Assessing Governance Practices for Low-Carbon Mobilities Futures.

Cristina Temenos

Geography, University of Manchester

Enlarging the scope of mobilities research to compare urban phenomena such as sustainable low-carbon transition across cities in the global north and global south is beginning to produce new ways of understanding urban development, transportation infrastructures and policymaking. Drawing on conceptualizations of *Policy Assemblages*, the bringing together of people, resources, and governance practices to create localized solutions to low carbon transition that simultaneously draw on practices elsewhere, this presentation asks questions such as: what roles do governance institutions play in the implementation of sustainable mobility transition policies How do these roles differ across places? What can be learned from studying sustainable transition *policies* and the processes that occur to implement them? What are the practical implications for local policy implementation, and how can they be translated into action? By examining questions such as these, this presentation focuses on the theoretical breakthroughs and challenges that arise when embarking on new constellations of mobilities research.

121 Sustainable Approaches to Greywater Recycling

Manoj Kumar Tiwari, Raj Shekhar Bose

School of Water Resources, Indian Institute of Technology Kharagpur

Sustainable freshwater management is one of the biggest challenges of the contemporary world. With several regions in the world already water stressed, further curbing of freshwater resources due to pollution loads are worsening the situation. Recycling and reuse of greywater (wastewater from kitchen, laundry, bathroom etc.) is perceived as one of the most sustainable approaches to pollution control of natural resources as well as serving as an alternate water resource, which collectively helps in reducing qualitative and quantitative stress on freshwater resources. A conservative estimate suggested that recycling 75% of greywater would effectively fulfill the majority of non-potable domestic water requirements. Alternatively, it could substantially reduce the freshwater demand for urban landscaping. However, recycling requires appropriate treatment before its intended use, which could be costly at times. A thorough analysis of existing common and emerging methods of greywater treatment indicated that different approaches may prove financially viable and environmentally sustainable, depending on the characteristics of the greywater and intended reuse post treatment. A decision chart was developed to facilitate the specific treatment choice selection for the greywater recycling for restricted, or non-restricted public access, primarily based on the influent Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD), and total coliform levels. The analysis indicated that, for usage in restricted public access, constructed wetland treatment with appropriate retention time should be preferred, irrespective of TSS and BOD concentrations. However a pre-treatment or policing treatment may be recommended for a higher degree of treatment. For non-restricted public uses, physicochemical treatment processes, such as coagulation or electrocoagulation, flocculation and primary filtration, shall be supplemented with modern low-energy membrane processes to ensure the outflow of safe and acceptable water quality. Further, greywater recycling is not a mere technological challenge. Social acceptance of greywater recycling also needs to be addressed through improving public perception towards greywater recycling with public awareness campaigns, rewards and subsidies.

122 Dimensions of Future Water Security – a Global Hydro-Economic Classification of Water Challenges

Sylvia Tramberend[1], Günther Fischer[1], Yusuke Satoh[1], William Cosgrove[1], Simon Langan[1], Taher Kahil[1], Eva Hizsnyik[1], Edward Byers[1], Peter Burek[1], Martina Flörke[2], Naota Hanasaki[3], Somayeh shadkam[1], Piotr Magnusziewski[1], Yoshihide Wada[1, 4, 5, 6]

[1] International Institute for Applied Systems Analysis (IIASA), Schlossplatz 1, 2361 Laxenburg, Austria
[2] Center for Environmental Systems Research, University of Kassel, Kassel, Germany
[3] National Institute for Environmental Studies, Tsukuba, Japan
[4] Department of Physical Geography, Utrecht University, Utrecht, The Netherlands
[5] NASA Goddard Institute for Space Studies, 2880 Broadway, New York, NY 10025, USA
[6] Center for Climate Systems Research, Columbia University, 2880 Broadway, New York, NY 10025, USA

Following a systems analysis risk-science perspective the Water Futures and Solutions Initiative (WFaS) coordinated by the International Institute of Applied Systems Analysis (IIASA) has developed a novel methodology for measuring water security and water challenges. The hydro-economic classification connects a region's water-related challenges with coping capacity to facilitate a differentiated analysis of water development challenges, prioritization of targeted solutions and provide a flexible tool for scenario assessment and stakeholder involvement. The hydro-economic classification indicator depicts countries and watersheds in a two-dimensional space using normalized indicators of hydrological complexity (x-axes) and economic-institutional coping capacity (y-axes). Hydrological complexity is measured by an weighted composite indicator based on four component indicators: i) total renewable water resources per capita; ii) intensity of water use; iii) runoff variability; and (iv) dependency of external water resources. Economic-coping capacity uses GDP per capita as proxy and, depending on the spatial and temporal scale of analysis and related data availability, additional indicators like the human development

index, education or government effectiveness. The hydro-economic classification scheme was used to delineate key scenario drivers of the WFaS multi-model scenario assessment. Hydro-economic challenges evolve over time and space reflected in a shift of countries or watersheds in the hydro-economic classification diagram. We present the development of a hydro-economic classification until 2050 for global watersheds. Economic-institutional coping capacity is key for capturing water security development trends. Yet, data are scarce and uncertain, in particular for future periods. We discuss data availability, ramifications for the hydro-economic classification, and potential implications for sustainability.

123 The Future of NRW—Participation of the Youth as Part of a Social Transformation Towards Sustainable Development

Mona Treude, Dorothea Schostok, Oscar Reutter, Manfred Fischedick

Wuppertal Institute for Climate, Environment and Energy, Germany

The future belongs to the youth, but do they get to have a say in it? Participation is the key to successfully developing a truly impactful sustainability strategy [1]. Learning processes with regard to a successful socio-ecological change must start in childhood and adolescence in order for the social transformation to succeed. The youth cannot be a passive part in a changing society, they have to be actively included in its design. When allowed to participate, young people can make important and effective contributions which should not be reduced to sub-projects and opportunity structures [2]. In a socio-political context, participation means involvement, collaboration and commitment. In the context of intra- and inter-generational equity, as the core part of sustainable development [3], participation strategies should be developed that allow for permanent and purposeful involvement of children and adolescents. Participation of young people is an important and appropriate step in strengthening those who are so strongly affected by the planning processes but otherwise powerless [4]. Successful involvement and participation of non-professional actors requires a target-group-oriented method, a supportive culture of participation as well as a clarity and decision latitude. Abiding by these rules leads to central results [5].

Participation formats are often not adequately geared towards the involvement of children and young people and require age-appropriate adjustment to this target group [6]. As part of the development of the mission statement "Sustainable North Rhine-Westphalia 2030"[7], one project work package empirically analysed two different exemplary approaches for the involvement of young people. One important issue here was to find the right balance between offering sufficient opportunities for participation on the one hand, and asking too much of the children and adolescents on the other hand. The first selected approach was an activating workshop with participants in a youth-only and youth-friendly setting

provided by the Regional Youth Council of North Rhine-Westphalia [8]. The second approach was a classic and rather conservative discussion forum, which included many actors from sustainability-related professions and took place during the 4th Sustainabliliy Conference of the federal state of North Rhine-Westphalia. Both approaches used the same visual real-time documentation, an innovative multimedia format called graphic recording, realised by the same illustrator. As a result, the activating workshop is, despite the lower number of participants, the preferably selected participation format.

Furthermore, our experience shows that participation formats should address the following criteria to ensure successful involvement:

1. Include only actors with intrinsic motivation
2. Design the key questions to be as focused as possible and as open as necessary
3. Provide a suitable place for a successful discussion
4. Create an open and inviting atmosphere for participation
5. Use the results beneficially and profitably.

This paper presents an approach, results and lessons learnt from the vision development within the on-going scientific project “Sustainability Strategy for North Rhine-Westphalia (NRW)—Conceptual Analyses and Considerations on Designing a Sustainability Strategy NRW from the Science Perspective” (2013–2017). It accompanies the development of the sustainability strategy for the federal state of NRW, which is envisaged to be adopted in 2016. This paper presents the experience of this real-world case of transformative science with regard to vision development. Project Website: http://wupperinst.org/en/p/wi/p/s/pd/469/

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124 Policy Relevant Evidence for South African Green Economy and Environmental Sustainability Transitions (PRE-SAGEEST) 2009–2016

Mapula Tshangela

National Department of Environmental Affairs

South Africa's May 2010 national green economy summit committed the country to "pursue and explore opportunities" in the green economy. The country subsequently implemented several green economy initiatives in the context of sustainable development. The Department of Environmental Affairs committed to promoting science-policy interface and evidence-informed policy making in its environment sector, research, development and evidence framework of 2012. Through an exploratory evidence review, in this paper, existing formal research produced in 2009–2016 is identified, appraised and synthesized. The synthesis contributes knowledge to revealing the gaps, trends and emerging patterns of research evidence generated, with particular interest on the spread within South Africa's nine focus areas of the green economy. Such synthesized research evidence is relevant to contributing to the green economy and environmental sustainability policy discourse. Such evidence may contribute to science-policy intervention areas towards achieving the Sustainable Development Goals by 2030.

125 A Systematic Review and Synthesis of Research and Practice: Linking an Organisation's Strategic Planning with a National Vision for a Sustainable Future - the Case of FNB Namibia

Chanel Venter, Nina Louw

Department of Business Management, Stellenbosch University

A global shift towards sustainable practices is evident and multi-stakeholder collaboration has emerged as a key success factor in reaching a shared sustainable future. Global Sustainability initiatives aim to inform these collaborative relationships in the public and private sectors. On a national level, it calls for national development plans and subsequent policy-making to follow suit. However, evidence of the collaboration in planning towards a shared sustainable future is lacking, and even more so in developing countries such as Namibia. From an organisational perspective, non-collaborative practices hinder the potential shared value to be derived by all stakeholders.

As a first step towards informing organisations about strategically planning for corporate sustainability, the need exists to identify current best practices within organisations to better understand how and if organisations link their strategic planning to a national vision for a sustainable future.

This study thus had the aim to fill the identified gap by first systematically examining the literature for evidence of the purposeful inclusion of sustainability in the strategic planning processes of organisations and how this is done. Primary research was conducted through a focused case study approach (focused on a large bank in Namibia), utilising semi-structured interviews with executive committee members and organisational documentation as datasets to explore sustainability as a business imperative and how FNB Namibia linked their strategic planning to a national vision for a sustainable future.

Results lead to the redefinition of Corporate Sustainability from a Namibian perspective and highlighted that the context in which organisations operate is strongly influenced by the political environment. Shared value creation in terms of social, economic, and environmental capital is thus created within a specific political sphere.

As a result of the synthesis between theory and practice, an integrated model is proposed which could be utilised to map the current strategic mode the organisation is operating from and how this in turn informs their strategy. Practitioners can also use the model as an integration tool towards a shared vision for a sustainable future.
Future research could focus on expanding the model to include best practices of strategic planning implementation.

126 Managing the Water–Energy–Food Nexus in a Frontier Economy: The Case of Kenya

Jeremy Wakeford

Quantum Global Research Lab

In recent years, the complex interdependencies among water, energy and food (WEF) systems have emerged as a central issue within the overlapping scientific fields of sustainable development and climate change resilience. This paper conducts a case study of the WEF 'nexus' in Kenya, a dynamic lower-middle-income 'frontier' economy. Kenya is of particular interest for several reasons. First, the country is acutely vulnerableto climate change and variability, given its geographical location in equatorial East Africa and its current dependence on largely rain-fed agriculture for nearly one-third of its gross domestic product. Second, following discoveries of oil resources in recent years, Kenya is poised to begin oil production in 2017, which could have a substantial impact on the country's ensuing developmental trajectory. Third, Kenya has been a leader within Africa in developing certain types of renewable energy, such as geothermal power and roof-top solar photovoltaic electricity. This paper explores the major global and national drivers affecting the WEF nexus in Kenya, such as a high rate of population expansion, rapid urbanisation and robust economic growth, and identifies the country's main water, energy and food security vulnerabilities and risks. It then assesses the different pathways that the country could take, depending on how it utilises its natural resources. Will Kenya succumb to the 'resource curse' that has afflicted so many African countries in the past, with resource rents captured by a small elite while local communities suffer from pollution of their water and soil as a consequence of oil extraction? Or will Kenya reinvest oil revenues in more sustainable infrastructure, production and delivery systems so as to improve food, energy and water security for the entire population? This paper puts forward policy recommendations for enhancing resilience and promoting sustainable development, and assesses the potential costs of insurance and nexus risk-mitigating investments. These policy lessons will be of relevance not just to Kenya, but also to other sub-Saharan African and frontier economies with similar profiles.

127 Linking Landscape Based Stormwater Management with Household and Community Livelihoods in Two African Cities

Kumelachew Yeshitela[1, 3, 4], Tatu Limbumba[2], Liku Workalemahu[1, 3, 4], Ketema Abebe[1, 3, 4], Lise Herslund[5]

[1] Ethiopian Institute of Architecture, Building Construction and City Development, Addis Ababa University, Addis Ababa, Ethiopia
[2] Institute of Human Settlement Studies, Ardhi University, Dar es Salaam, Tanzania
[3] Ethiopian Institute of Architecture, Building Construction and City Development, Addis Ababa University, Addis Ababa, Ethiopia
[4] Ethiopian Institute of Architecture, Building Construction and City Development, Addis Ababa University, Addis Ababa, Ethiopia
[5] Department of Geosciences and Natural resources Management, University of Copenhagen

Due to climate change and rapid urbanization, African cities are being increasingly affected by flooding, affecting critical infrastructure and vulnerable people. The problem is aggravated by insufficient stormwater sewer lines and poor waste management. Addis Ababa, the capital of Ethiopia, and Dar es Salaam, the capital of Tanzania, are among the cities that are affected by flooding. Within the framework of a project—Water Resilient Green Cities for Africa—the importance and value of green infrastructure for stormwater management and improving the livelihood of the local community has been investigated. A single river catchment is selected in both cities, and pilot sites with water supply and flooding problems were considered for the livelihood study. Household interviews, focus group discussions and transect walks were conducted to collect data. The major livelihood activities related to green and water resources in Addis Ababa are urban agriculture (field crop and vegetable farming) and water vending from borehole and municipal supply. In Dar es Salaam, gardening, water vending from borehole, food and vegetable vending and brick making are the livelihood activities related to green and water resources. These economic benefits that are derived from the green infrastructure are opportunities for implementing landscape based stormwater management in the selected river catchments. In addition, the information obtained also

showed the use of the green spaces for recreation, socializing and to mitigate temperature increase. For low income households and communities, economic benefit outweighs the environmental benefits that could be obtained from green spaces. Therefore, the local stormwater management strategy for the two river catchments should build on the existing economic benefits and provide additional options for enhancing and improving household and community livelihoods for the development, preservation and restoration of green space in the river catchments.

5
Poster Presentation Abstracts

1. Sustainability and Competitiveness at the Regional Level: An Empirical Approach to Analyze the Stakeholders' Relationship of Firms

M. Isabel Sanchez-Hernandez

University of Extremadura

Nowadays, any business manager is concerned about sustainability issues and is wondering how to implement social and environmental practices, creating economic and social value at the same time. The implementation of social responsibility (SR) programs is justified by the benefits that used to result from the relationships with the key stakeholders. We refer, for instance, to the enhancing of firm reputation (Park et al., 2014), the increase in the number of customers, their satisfaction, loyalty and identification with the company (Servaes and Tamayo, 2013), the motivation of employees in order to get more productivity and shared company values (Dogl and Holtbrugge, 2014) and more interested investors in companies which satisfy SR criteria (Girerd et al., 2014). Building reputation with key stakeholders and corporate branding in the market entail considerable challenges to firms in terms of transparency, authenticity and accountability, which is related to firm competitiveness and performance (Surroca et al., 2010).

The present research investigates the links among stakeholders´ relationships, champion behavior, stakeholders´ satisfaction and the competitive success of firms in regional contexts where SR is being promoted. Using the resource-based theory and the concept of shared value, the authors propose a conceptual model in which the firms' relationship with their stakeholders will lead to their satisfaction and will help the firm to become a champion in the market, contributing to improved competitiveness. The empirical analysis was based on survey data through partial least squares structural equation modeling (PLS-SEM) from 130 Spanish firms in the Region of Extremadura. Participants were firm managers, in regional clusters, involved in the SR journey promoted by the local government. The results suggest that stakeholders´ relationship directly and positively influences the firms' competitive success and it is also enhanced by improvements in stakeholders´ satisfaction and firm champion behavior.

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2. A Management Database for Sustainable Cattle Production by Emerging Cattle Farmers in South Africa

Obvious Mapiye

Faculty of Agri-sciences Department of Animal Science University of Stellenbosch, South Africa

Several challenges have been identified in literature as negatively affecting smallholder cattle production. The challenges result in low productivity and off take rates from both communal and emerging producers. Using a sample of 62 emerging cattle farmers, whose operations can be classified as between communal and commercial scale, we explore whether the farmers face the challenges as identified in literature. We also identify the lack of information sharing among these farmers and a weak extension system as serious constraints to production. To address this situation, in this study we develop a database that assists emerging farmers to achieve sustainable cattle production. The database allows farmers to upload information about their farms, the constraints they have faced in cattle production and the solutions they used to address the constraints and how effective the solutions were. Farmers can access this information, ideally through a mobile phone application, so that they do not have to re-invent the wheel every time they face a challenge. Furthermore, the extension system can also access the database and provide advice based on farmers submissions. Initially the database will be made available to farmers at no cost but eventually farmers are expected to pay for the service so as to make the database self-sustaining.

3. Assessing Water Quality from the Diversity of Benthic Macroinvertebrate Communities in Rivers of the Albertine Rift Region in Western Uganda

Peace Liz Sasha Musonge

Ghent University

The Albertine Rift region and Rwenzori Mountains of western Uganda are part of a globally recognized biodiversity hot spot, but are currently undergoing increasing development for mineral exploitation and hydroelectric power generation. As little is known about how significantly these human activities impact the biodiversity and water quality of the region's rivers, this study was undertaken to assess the ecological water quality of three rivers draining the Rwenzori in southwestern Uganda, based on the family-level taxonomic diversity and spatial distribution of benthic macro-invertebrate communities.

We sampled aquatic macro-invertebrates at 71 sampling sites in the main channel and head water tributaries of the Nyawamba, Mubuku, and Nyamugasani rivers, and identified a total of 32,579 specimens at the family level. Insecta was the most diverse taxon (45 families) followed by Gastropoda (5 families); Oligochaeta (2 families); Hirudinea (1 family); Arachnida (1 family); Malacostraca (1 family); and Turbellaria (1 family). Ecological site classification based on the Average Score Per Taxon (ASPT) criterion indicated that 41 sites could be classified as natural (and thus undisturbed), 15 as good, 7 as moderate, and 8 as poor. At all 71 sites, a representation of at least pollution-sensitive *Ephemeroptera*, *Plecoptera,* and *Trichoptera* (EPT) was found, with Ephemeroptera being the most abundant (11,359 individuals from 6 families), followed by Trichoptera (3196 individuals from 4 families), and Plecoptera (24 individuals from 1 family). Upstream sites had the highest abundance of pollution-sensitive taxa such as Baetidae, Caenidae, and Hydropsychidae, while downstream sites were characterized by high numbers of Chironomidae.

Four diversity indices were calculated: Shannon-Wiener, Simpson, Pielou's evenness, and Gini coefficient. Lorenz curves and Gini coefficients were used to illustrate the evenness in taxon abundance between sampling sites and to further highlight anthropogenic *disturbance patterns* influencing

diversity. The Gini coefficient highlighted a high unevenness in taxa composition between the four ASPT water quality types, indicating that anthropogenic disturbances and micro-habitat diversity along the sampled streams affect the distribution of aquatic macro-invertebrates. Lorenz curves from all 71 sampling sites showed a relatively high degree of unevenness with values ranging from 0.75 to 0.94. Pielou's index values ranged from 0.49 for sites classified as poor to 0.58 for sites classified as natural. With the ongoing exploitation of the Rwenzori region for energy and copper ore production, the results of this study can be used as a baseline to assess future impacts of mining activities and the construction of hydroelectric power dams on the ecological integrity of the region's freshwater systems. Moreover, our findings of shifts in macroinvertebrate species composition due to anthropogenic disturbance can be applied to set up conservation and monitoring schemes in tropical rivers elsewhere.

4. Benthic Macroinvertebrate Functional Feeding Groups Patterns in Afro-Montane Rivers Relative to Physical Variables Land-Use and Physical Variables in Southwestern Uganda

Peace Liz Sasha Musonge

Ghent University

In order gauge the spatial distribution of macroinvertebrate functional feeding groups (FFGs) relative to land use types and physical variables along 71 sites in the Albertine rift valley Rivers (ARVR) in southwestern Uganda Artificial neural networks (ANN) were applied to the data set. The relative abundances of 5 functional feeding groups (FFGs) were computed from macroinvertebrate data identified to family level. Each sampled site was differentiated using 5 physical variables (altitude, river type, velocity, sediment matrix, channel pattern) and 3 land-use variables (forest and shrub, developed areas, agricultural areas). The sites were first categorized using the Kohonen's Self-Organizing Map algorithm (SOM), according to the land-use and physical variables. To examine the variability of the macroinvertebrate communities, functional feeding groups (FFGs) proportions at all 71 sites were examined on the SOM trained with physical and land-use variables. When the riverine landscape was natural, functional feeding groups (FFGs) patterns responded to the upstream downstream gradient with physical variables. However, when the landscape was altered by agriculture or urbanization, the effects of land-use on functional feeding groups (FFGs) overcame the influence of the physical variables. The categorization of the landscape into forested, agricultural, and urban areas was relevant to detect changes in functional feeding groups (FFGs) patterns. In light of projected developments along riparian zones in the region, the use of SOMs to detect responses of functional feeding groups (FFGs) to landscape alterations at local scales represents a useful approach for ecological assessment of freshwater systems based on functional feeding indicator groups.

6
List of Participants

Acemah
Christian
UNAS

Adebayo
Stephen Adewale
Integration Company Limited
temmydee2008@gmail.com

Aginam
Obijiofor
United Nations University (UNU)
aginam@unu.edu

Ahmed
Abdelmoneim
Stellenbosch University
aahmed@sun.ac.za

Aina
Yusuf
Yanbu Industrial College
ainay@rcyci.edu.sa

Aina
Akin Tade
PASGR

Akachukwu
Doris
Michael Okpara University of Agriculture; Umudike
akachukwudoris@gmail.com

Akinsemolu
Adenike
Adeyemi College of Education
akinsemoluaa@aceondo.edu.ng

Alao
Olukayode
Politecnico di Milano
olukayodeolawale.alao@mail.polimi.it

Angala
Hallo
Rhodes University
halloangala@gmail.com

Ankamah
Sylvia
University of Energy and Natural Resources; Sunyani-Ghana
sylvia.ankamah@uenr.edu.gh
Anwar
Sumera
Huazhong Agricultural University
sumeraanwar@mail.hzau.edu.cn
Arbab
Shandara
University of Engineering and Technology; Peshawer
circe17_1992@hotmail.com
Armitage
Neil
University of Cape Town
Neil.Armitage@uct.ac.za
Babajide
Omotola
Cape Penninsula University of Technology
omotola.babajide@gmail.com
Badmos
Biola Kazeem
Kwara State University
biolakz@yahoo.com
Badmus
Kassim
University of the Western Cape
3481395@myuwc.ac.za
Bailliu-Chaloux
Alizé
Algonquin College
bail0149@algonquinlive.com
Baldeh
Sheikh Omar
Center for Socioeconomic Policy Environmental Research and Social Development
Info.cesepordev@gmail.com
Balogun
Saheed Olatunji
Achuka Global Concepts Limited
luvtunji@yahoo.com

Bawua
Abigail Serwaa Akoto
University of Ghana; Legon
winylore@gmail.com

Bawua
Serwaa Akoto
University of Ghana; Legon
winylore@gmail.com

Beavon
Corey
University of Cape Town
BVNCOR001@myuct.ac.za

Bergman
Max
University of Basel; University of the Western Cape
max.bergman@unibas.ch

Bergman
Zinette
University of the Witwatersrand
zinette.bergman@unibas.ch

Beru
Douglas
Vihiga County
vihigaprojects@gmail.com

Bikeko
Samuel Shibeshi
Wachemo University
samuelshibeshi2@gmail.com

Black
Hedwig
University of the Witwatersrand
nelly.black52@gmail.com

Blit Cohen
Edith
Hebrew University
edith@blitcohen.com

Boshoff
Daniel
University of South Africa
boshods@unisa.ac.za

Bradshaw
Dee
University of Cape Town
dee.bradshaw@uct.ac.za

Bressers
Hans
University of Twente
j.t.a.bressers@utwente.nl

Brito
Lidia

Broadhurst
Jennifer
University of Cape Town
jennifer.broadhurst@uct.ac.za

Bruno
Lokonon
University of Abomey-Calavi
brunolokonon@gmail.com

Burgener
Marie Laure
GreenGoWeb
mburgener@gmail.com

Burkhalter
Matthias
MDPI AG
burkhalter@mdpi.com

Carden
Kirsty
University of Cape Town
kirsty.carden@uct.ac.za

Carlos da Silva
Francisco

fracarlos@hotmail.com

Carrese
Stefano
University of Roma Tre
stefano.carrese@uniroma3.it

Centner
Terence
University of Georgia
tcentner@uga.edu

Chabalala
Simphiwe
University of the Witwatersrand
1028337@students.wits.ac.za

Chantson
Janine
University of the Western Cape
jchantson@uwc.ac.za

Chibueze
Chibuike John
Top Skill Ventures
mikemon29@yahoo.com

Chicksen
Brian
AngloGold Ashanti Ltd
bchicksen@anglogoldashanti.com

Chien
Lien Kwei
National Taiwan Ocean University
lkchien@mail.ntou.edu.tw

Chiluwe
Quinex
University of Pretoria
qchiluwe@gmail.com

Chineke
Theodore Chidiezie
Imo State University
chidiezie@gmail.com

Choongo
Progress
VU University Amsterdam
p.choongo@vu.nl

Christie
Lorna
Unisa
lornaschristie@gmail.com

Claudelin
Anna
Lappeenranta University of Technology
anna.claudelin@lut.fi
Cohen
Tracey
UNISA
cohent@unisa.ac.za
Colorado
Gabriel
Universidad Nacional de Colombia
gjcoloradoz@unal.edu.co
Cresswell
Tim
Trinity College
timothy.cresswell@trincoll.edu
Crockett
Abbey
Fairmont Hotels and Resorts
abbey.crockett@fairmont.com
Davies
Megan
Stellenbosch University
megandavies@sun.ac.za
de Groot
Jiska
University of Cape Town
jiska.degroot@uct.ac.za
Dilling
Petra F.A.
New York Institute of Technology
pdilling@nyit.edu
Dube
Admire
University of the Western Cape
adube@uwc.ac.za
Dube
Oliver
National University of Science and Technology (NUST)
odoliverdube@googlemail.com

Duffy
Kevin
Durban University of Technology
kevind@dut.ac.za

Echereobia
Christopher
Federal University of Technology Owerrl Nigeria
echereobia@yahoo.com

Ellamla
Harikishan Reddy
University of Western Cape
3380313@myuwc.ac.za

Emmanuel
Mvula Mampasi
Ministry of Environment and Sustainable Development
emmamvula@gmai.com

Epule
Terence Epule
McGill University
terence.epule@mail.mcgill.ca

Fischedick
Manfred
Wuppertal Institute for Climate; Environment and Energy
manfred.fischedick@wupperinst.org

Florence
Rudolf
Insa
florence.rudolf@insa-strasbourg.fr

Fouche
Elaine
University of Stellenbosch
foucheelaine@sun.ac.za

Frattari
Antonio
University of Trento
antonio.frattari@unitn.it

Gasparatos
Alexandros
University of Tokyo

Gaudino
Pierre
IRE SNCF - Forum Vies Mobiles
pierre.gaudino@sncf.fr

Gay
Christophe
IRE SNCF - Forum Vies Mobiles
christophe.gay@sncf.fr

Gcanga
Amanda
Stellenbosch University
amandag@sun.ac.za

Ghimire
Karuna Kar
Paribartan Nepal;NGO
paribartan.org@gmail.com

Gonzalez
Carlos
Oregon State University
Carlos.Gonzalez@oregonstate.edu

Grella
Catrina
Hasso Plattner Institute
catrina.grella@hpi.de

Groeneveld
Anouschka
Wageningen University
anouschka.groeneveld@wur.nl

Gyesu
Eric
Rotaract
da2ruprince@gmail.com

Habtemariam
Kumelachew Yeshitela
Addis Ababa University
kumalachew.yeshitela@eiabc.edu.et

Hawkins
Heidi-Jayne
Conservation South Africa
hhawkins@conservation.org

Haywood
Lorren
CSIR
lhaywood@csir.co.za

Hofmann
Jana
University of East Anglia
J.Hofmann@uea.ac.uk

Ikusika
Craig Kofoworola
Ladoke Akintola University of Technology; Ogbomoso
ikusikacraig@yahoo.com

Janke
Rhonda
Sultan Qaboos University
Parideaza@gmail.com

Jankielsohn
Astrid
ARC-Small Grain Institute
jankielsohna@arc.agric.za

Jansson
Johan
Lund University School of Economics and Management
johan.jansson@fek.lu.se

Jordaan
Henry
University of the Free State
jordaanh@ufs.ac.za

Jordaan
Jana
GreenCape
jana@green-cape.co.za

Jules Eric Yves
Mihamle
MISAPA - Cameroun (mission africaine de promotion agropastorale)
jmihamle@yahoo.fr

Kalamas Hedden
Maria
Kennesaw State University
mkalamas@kennesaw.edu

Kambule
Njabulo
Unviversity
njabs4life@gmail.com

Karongo
Catherine
Ogilvy Public Relations; Kenya
Catherine.Karongo@ogilvy.co.ke

Kato
Shuhei
University of Cape Town
KTXSHU001@myuct.ac.za

Khan
Farhan
Harry
harrytoursntravels@gmail.com

Khumalo
Nontokozo
Standard Bank
nontokozo.khumalo@standardbank.co.za

Kobamo
Adane Haile
Wachemo University
adanehaile37@gmail.com

Konsti-Laakso
Suvi
Lappeenranta University of Technology
suvi.konsti-laakso@lut.fi

Krenz
Juliane
University of Basel
juliane.krenz@unibas.ch

Kuhn
Nikolaus
University of Basel
Nikolaus.Kuhn@unibas.ch

Kuokkanen
Anna
Lappeenranta University of Technology
anna.kuokkanen@lut.fi

Lachman
Kevish
Auditor General of South Africa
banyanas@agsa.co.za

Landrième
Sylvie
IRE SNCF - Forum Vies Mobiles
sylvie.landrieve@sncf.fr

Lawal
Nurudeen
Olabisi Onabanjo University
nslawal@oouagoiwoye.edu.ng

Le Roux
Catherine
UNISA
lrouxc1@unisa.ac.za

Leino
Maija
Lappeenranra University of Technology
maija.leino@lut.fi

Lena
Berger
University of Basel
lena.berger@unibas.ch

Liu
Guoshui
MDPI AG

Lukas
Megan
University of Cape Town
megan.lukas@gmail.com

Mabhaudhi
Tafadzwanashe
University of KwaZulu-Natal;
mabhaudhi@ukzn.ac.za

Machel
Graca
Sustainable Development Advocate for the United Nations

Magoda
Zinzi
Cape Peninsula University of Technology
nxopoz@cput.ac.za

Makoya
Precious
UNISA
makoyaprecie@webmail.co.za

Malgas
Rhoda
Stellenbosch University
rmalgas@sun.ac.za

Mapendere
Cynthia
University of Pretoria
cmapendere@yahoo.com

Mapiye
Cletos
Stellnbosch university
cmapiye@sun.ac.za

Marafa
Lawal
The Chinese University of Hong Kong
Lmmarafa@cuhk.edu.hk

Marriott
Michael
Marine Stewardship Council
michael.marriott@msc.org

Marx-Pienaar
Nadene
University of Pretoria
nadene.marxp@up.ac.za

Mballa-Ekobena
Marcel
Agricultural Entrepreneur

Mellor
Meredyth
Transfauna Ltd
meredythmellor@gmail.com

Mensah
Sylvanus
Stellenbosch University
18208533@sun.ac.za

Mgwebi
Thandi
University of the Western Cape
tmgwebi@uwc.ac.za

Mohlakoana
Nthabiseng
University of Twente
n.mohlakoana@utwente.nl

Moja
Teboho
New York University
tm45@nyu.edu

Molotsi
Annelin
University of Stellenbosch
annelind@sun.ac.za

Mpandeli
Sylvester
Water Research Commission
sylvesterm@wrc.org.za

Mthembu
Dumisani
Department of Science and Technology
dumisani.mthembu@dst.gov.za

Muchenje
Voster
University of Fort Hare
Vmuchenje@ufh.ac.za

Muesgens
Felix
Brandenburg Unviversity of Technology
muesgens@b-tu.de

Mugume
Isaac
Makerere University
imugume@caes.mak.ac.ug

Muhammad
Anelisa
Cape union mart
alarakab@yahoo.com

Murphy
Kevin
Washington State University
kmurphy2@wsu.edu

Musonge
Peace Liz Sasha
Ghent University
peacesasha@gmail.com

Nanda
Madhuri
TERI University
madhuri.nanda@students.teriuniversity.ac.in

Ndlovu
Aros
University of Johannesburg
aros.ndlovu@gmail.com

Ndlovu
Joy-Noeleen
National University of Science and Technology
noeleenndlovu@gmail.com

Neimane
Leila
University of Latvia/University of Pretoria
leila.neimane@eia.lv

Ng
Ai Sian
Wee Kim Wee School of Communication and Information; Nanyang Technological University
ng0030an@ntu.edu.sg

Ngeh
Emmanuel Ngenge
Young Farmers Development Group
emmanuel.ngenge@yahoo.com

Ngila
Dorothy
National Research Foundation
dorothy.ngila@nrf.ac.za

Ngumbi
Esther

enn0002@tigermail.auburn.edu
Nikolaeva
Anna
University of Amsterdam; Utrecht University
a.nikolaeva@uva.nl
Niyobuhungiro
Rissa
University of Cape Town
nybris001@myuct.ac.za
Njobe
Bongiwe
ZANAC CONSULTING
bn.njobe@gmail.com
Nkhoma
Lusungu
University of the Witwatersrand
lusungu.nkhoma61@gmail.com
Nkonu
Kwame Michael
IUCN - (International Union for the Conservation of Nature)
michael.nkonu@iucn.org
Nnamani
Catherine V.
Ebonyi State University Abakaliki; Nigeria
drnnamanikate@gmail.com
Noubactep
Chicgoua

cnoubac@gwdg.de
Nwaokocha
Collins
Olabisi Onabanjo University; Ago-Iwoye; Nigeria
collinsnwaokocha@gmail.com
Nyallang Nyamsi
Serge
University of the Western Cape
nyamsiserge@yahoo.fr

Oelofse
Suzan
CSIR
soelofse@csir.co.za
Oke
Ayodeji
University of Johannesburg
emayok@gmail.com
Okedairo
Emmanuel Gbenga
Fatow Investments Limited
julius_emoekpeire@yahoo.com
Okedi
John
University of Cape Town
jokedi@gmail.com
Okeye
Valentine Ebuka
the university of Ibadan
twopam4u@yahoo.com
Olaniyi
Akeem
Osun State College of Education, Nigeria. Universiti Putra, Malaysia
olaniyi.environment@gmail.com
Ololade
Olusola
University of the Free State
shola.ololade@gmail.com
Olukoya
Obafemi A.P
Brandenburg Technical University
olukoyaobafemi@yahoo.com
Onacha Kisia
Tom
Vihiga County
vihigaprojects@gmail.com
Opoku
Samuel
Shardfo-Tech Company Limited
shardfotechcomltd@gmail.com

ORyan
Raul

raul.oryan@uai.cl

Ouikotan
Blandine
UNESCO-IHE Institute for Water Education
b.ouikotan@unesco-ihe.org

Owusu-Sekyere
Enoch
University of the Free State
kofiwusu23@gmail.com

Pahwa Gajjar
Sumetee
IIHS
spgajjar@iihs.ac.in

Panagopoulos
Andreas
Hellenic Agricultural Organisation
Panagopoulosa@gmail.com

Partridge
Andrew
Western Cape Department of Agriculture
andrewp@elsenburg.com

Phakeng
Mamokheti
University of Cape Town

Pillay
Gansen
National Research Foundation

Quiroga
Sonia
University of Alcala
sonia.quiroga@uah.es

Rahil
Abdulla

p13063959@my365.dmu.ac.uk

Rainone
Mario Luigi

rainone@unich.it

Ramadan Wunzalgu
Abdul Aziz Mohammed
University for Development Studies
aziz0639@gmail.com

Rambau
Takalani
Auditor General
banyanas@agsa.co.za

Rampedi
Isaac
University of Johannesburg
isaacr@uj.ac.za

Ray
Charlotte
University of Nottingham
Charlotte.ray@nottingham.ac.uk

Reddy
Daya
University of Cape Town
daya.reddy@uct.ac.za

Rege
Edward
Emerge-Africa
ed.rege@picoteamea.org

Roboji
Zukiswa
Full time student at North West University
zukiswaroboji@gmail.com

Rosen
Marc
University of Ontario Institute of Technology
marc.rosen@uoit.ca

Rueff
Henri
University of Basel
henri.rueff@unibas.ch

Russo
Valentina
University of Cape Town
v.russo@uct.ac.za
Sachs
Jeff

Sachs
Sonia

Sanchez-Hernandez
M. Isabel
University of Extremadura (Spain)
isanchez@unex.es
Sandström
Niclas
University of Helsinki
niclas.sandstrom@helsinki.fi
Sanye-Mengual
Esther

esther.sanye@unibo.it
Schaller
Florian
University of Liechtenstein
Florian.Schaller@uni.li
Scharfy
Deborah
Zurich University of Applied Sciences
scaf@zhaw.ch
Schostok
Dorothea
Wuppertal Institute for Climate; Environment and Energy
dorothea.schostok@wupperinst.org
Sehlapelo
Desiree
UNISA
desiree.sehlapelo@gmail.com

Sibanda
Lesley
University of Cape Town
Lesley.Sibanda@uct.ac.za
Siebert
Rosemarie
Leibniz Centre for Agricultural Landscape Research (ZALF)
rsiebert@zalf.de
Solaja
Mayowa
Olabisi Onabanjo University
solaja.mayowa777@yahoo.com
Solomon
Michael
University of Cape Town
michael.solomon@uct.ac.za
Sonnenberg
Nadine
University of Pretoria
nadine.sonnenberg@up.ac.za
Stafford
William
CSIR
wstafford@csir.co.za
Stroebel
Aldo
National Research Foundation
aldo.stroebel@nrf.ac.za
Stucki
Matthias
Zurich University of Applied Sciences
matthias.stucki@zhaw.ch
Suransky
Carolina
University of Humanistic Studies
c.suransky@uvh.nl
Swanepoel
Frans
University of Pretoria: Future Africa
frans.swanepoel@up.ac.za

Sykes
Aisha
Refined Advisory
Aisha@refined.co.tz
Taole
Nthabiseng
University of Pretoria
nthabiseng.taole@up.ac.za
Tejedor Flores
Nathalia Diazibeth
Technological University of Panama/University of Salamanca
nathalia.tejedor@usal.es
Temenos
Cristina
University of Manchester
cristina.temenos@manchester.ac.uk
Tramberend
Sylvia
International Institute for Applied Systems Analysis (IIASA)
trambers@iiasa.ac.at
Treude
Mona
Wuppertal Institute for Climate; Environment and Energy
mona.treude@wupperinst.org
Tshangela
Mapula
Department of Environmental Affairs
MTshangela@environment.gov.za
Vazquez
Franck
MDPI AG
vazquez@mdpi.com
Venter
Chanel
Stellenbosch University
chanelv@sun.ac.za
von Blottnitz
Harro
University of Cape Town
Harro.vonBlottnitz@uct.ac.za

Wagner
Nicole
Western Cape Department of Agriculture
nicolew@elsenburg.com
Wakeford
Jeremy
Quantum Global Research Lab
j.wakeford@quantumglobalgroup.com
Yeboah-Assiamah
Emmanuel
Stellenbosch University
19301537@sun.ac.za
Yoo
Sung-won
Gachon University
imysw@gachon.ac.kr
Yoro
Kelvin
University of the Witwatersrand
kelvin.yoro1@students.wits.ac.za
Zhang
Guoping
MDPI (Multidisciplinary Digital Publishing Institute)
terry.zhang@mdpi.com

WSF 2015

Toward a Sustainable Agriculture: Farming Practices and Water Use

Edited by Henry Jordaan and Manfred Max Bergman

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Globally, the agri-food sector has a major role to play in ensuring food security and economic development, especially for lower income countries. In the increasingly demanding context of environmental risk, exacerbated by climate change, and of environmental degradation, agricultural producers are faced with the challenge to meet the demand of the agri-food sector to feed growing populations in a sustainable manner while still trying to make ends meet.

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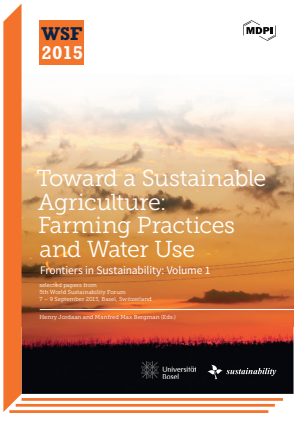

MDPI

MDPI AG
St. Alban-Anlage 66
4052 Basel, Switzerland
Tel: +41 61 683 77 34
Fax: +41 61 302 89 18
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