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True Smart and Green City?
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Smart by Nature: The Use of Swarm Planning in Creating Productive and Adaptive Urban Landscapes

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Abstract: A smart city is a city capable of adjusting its sizes, structures and shapes. Nature gives us the information how this could be achieved. The 'Software' of the city (green, water, food, sustainability, social constructs) is obstructed by the 'Hardware' (infrastructure, roads, sewage, buildings, economics). This makes it hard to create space for Climate Impacts and Urban Agriculture as their requirements are uncertain, temporary, change seasonally, occur suddenly and change over longer periods and street patterns, main structures and buildings are usually immovable. In this paper different types of uncertainty or change are identified and matched with according Urbanism concepts. Slow Urbanism is linked with a slow change and weak economic demand of certain land-use, such as Urban Agricuture while Suddenism is introduced as a way of urban design dealing with the sudden impacts of a climate (or natural) disaster. Becoming smart by nature, eg let the rules of nature guide us in city planning, could improve the adjustability of the city and allow spaces to shrink and grow, depending the needs at times. Nature's principles function as the ultimate smart design principles. For the city, as a complex adaptive system lessons can be learnt. The emergence, one of the properties of these systems gives us the spatial guide to adjust the city when slow change is desired, while Swarm behaviour guides us when a sudden change occurs. The Swarm Planning concept is capable to anticipate uncertain and sudden future change. Together emergence and Swarm Planning are capable to develop smart city designs, which are adjustable to uncertain future claims no matter whether they are developing slowly or happen suddenly. Hence, the city is able to include flexible spaces in which more room is available for the software of the city: this is what we can call Smart Green Urbanism. The paper describes, compares and discusses six case studies in which Emergence/Swarm

Planning is used for explorational designs to provide more space and flexibility for Sudden and Slow change. The way nodes and networks, determine the way unplanned (often unused) spaces are occupied), structures and systems are formed, hubs, exchange and intense connections lead to emergent occupation patterns, provide the space to accommodate both sudden (climate impacts) and slow (the growth of food) spatial claims.
Keywords: uncertainty, change, Swarm Planning, Suddenism, Slow Urbanism, Research by Design

1. Introduction

Our current urban environments are not prepared for the changes and adaptations necessary to produce substantial amount of food, nor can they accommodate the impacts of sudden climate change.

Our food production system is spatially separated and even spread out over the world. This has serious implications for food security, food safety, and has large impacts on our environment. At the same time climate change causes unprecedented impacts the fixed systems and structures have difficulties to adapt to. The combination of the two is even more. Can we design cities that are prepared for dealing with massive and surprising changes and accommodate the demand for locally produced food at the same time?

It is clear that currently cities cannot produce all the food consumed in the same city. In the Netherlands only 0.0018% of the total amount of consumed food is produced within city-limits (1). Similarly, disasters around the world show that urban areas are not prepared for high impact and surprising (climate) events. Therefore a transformation in the way we think about cities is necessary. Transition (2, 3, 4, 5, 6) and transformation theory (7, 8) are used in this article to identify the key elements of change, and is used to build up a new planning approach, swarm planning. The definition swarm planning can be summarized as follows: A spatial planning methodology, adjusted for and incorporating the characteristics of wicked problems on the basis of complexity theory (after http://swarmplanning.nl). Within the method the role of spatial design is seen as to identify those essential impulses, which are capable of influencing the whole system (9). When these impulses are located at strategic nodes, or hubs, in strong and intense networks (10). The theory has been put to practice in several spatial planning processes, such as in the 'Floodable Landscape' in Northern Netherlands, or the 'Bushfire Resilient Landscape' in Bendigo, Australia (11). The majority of these applications so far focus on spatial climate adaptation. This paper will extend the scope and include productivity issues in the city. The combinatory of space demanding land-use could offer benefits in dealing with unexpected surprises or unprecedented events. Therefore this paper focuses on the application of transformation theory in swarm planning approaches in planning for climate events and food production.

In section 2 the methodology of the research approach will be described. This is followed in section 3 by an observation how to deal with change and in section 4 by a brief introduction in the theoretical background of transformation and swarm planning. Section 5 describes and analyses several planning examples in which these theories have been applied. In section 6 the common grounds derived from

these plans are used to derive a new planning discourse. In section 7 the results are discussed and recommendations formulated, after which the paper is finalised with the conclusions (section 8).

2. Methodological approach

Change is nothing new. It happens all the time. However change can move in opposite directions. Some change is reasonably predictable, while other is unprecedented and surprising. The problem is how to synchronise these typological different changes and at the same time create a more adaptive environment. Of each of these types one phenomenon is taken to investigate this question. First, climatic impacts are seen as a disruptive and sometimes unprecedented change, which can be translated in a spatial claim. Secondly, the slow change of an increasing demand for urban food supply might be more predictable, but it claims also urban space. In this paper transition theory and the swarm planning methodology will be discussed first and related to the current planning discourse. The theory is used to design innovative solutions for pressing problems in six case studies. The regularities of nature are used to design these innovations in order to create adaptable solutions for uncertainties of the future. Out of these designs their strengths and weaknesses are combined and merged where possible. This Research by Design approach then leads to conclusions on a design methodology that builds in the flexibility and possibility to swap uses in urban spaces, which contributes to an emerging discourse for adaptive spatial planning.

3. Dealing with change

As mentioned before, change can manifest itself in different ways. When change is fast, i.e. the economic forces are so powerful the need for new land use and new urban areas are apparent, the spatial change is evident. This is what we generally would call urban development, and new housing, new economic areas, office buildings, recreation areas or shopping centres are planned. We could call this *Fast Urbanism*, because it is developed at a fast pace, in one Masterplan, with underlying precinct plans accommodating the demand of the moment.

When change is slow however, it can be better predicted and spatial configurations can be slowly adapted to new spatial claims. This is an emergent and incremental change, often not driven by strong economic forces. A good example is the recent quest for space to grow food in the city. Soft urban claims, i.e. the ones that are less of an economic factor, do generally not ignite a planning process (but for the topic at stake, they should). This is what can be called *Slow Urbanism*, because its development is slow, it'll develop incrementally and the pressure for land use change is absent of very low. The demand of urban residents for public space to be used to grow their food is therefore not often the starting point of spatial development or retrofitting in the city. This type of spatial claims should therefore link in with other processes to enforce spatial transformation.

One of the potential synergies is when sudden surprising or unprecedented change could occur. This kind of change might have massive consequences when the city is not prepared. The impact of a flood, bushfire, cyclone or earthquake comes by surprise and can be serious in terms of victims and economic damage. Because these events have not occurred before, the claim cannot be determined in great detail beforehand. This can be called *Suddinism*, because the space required as result from such an unprecedented event is needed suddenly or immediately, not after the events has diminished and the

pressure on land use change is extremely high and urgent. However, it is clear these climatic events require space in the city where their impact can be accommodated, for instance when a flood occurs there is space needed for temporary water storage, similarly space where a fire can come to rest in case of a bushfire etcetera. The location, size and shape of these spaces cannot be exactly predicted, but it is clear a range of different spaces, currently not available in an average city, should become available. When the quest for temporary spaces is lined up with the claim for predictable new spaces, both demands can mutually benefit from this.

Table 1. Overview characteristics different paces of Urbanism.

	Fast urbanism	**Slow urbanism**	**Suddenism**
Themes	Housing, urban development, commercial, industrial	Ecology, food, energy	Climate impacts, flood, bushfire, natural hazards, earthquake
Response	By itself, economic pressure	Requires external trigger, create spaces for transformative use	Create spaces, requires space to respond to external trigger
Dynamic	Predictable	Predictable, flexibility	Unprecedented, surprising Flexibility, dynamism
Planning type	Master planning,	Adaptive planning,	Adaptive planning, Swarm planning,
Type of change	Blueprint, planned change, end state	Slow transformation, incremental change, continuous change	Systems' flip, fast transformation, disruptive change

A spatial change is required when new urban uses, with according economic pressure, are desired (Fast Urbanism), slow incremental and soft demands are apparent (Slow Urbanism) or sudden change implies shifting uses (Suddenism). Under influence of economic pressure, changes in land use force an urban configuration in a well-understood and traditional way. We know how to develop new residential areas, industrial sites or shopping malls. But when the spatial claim is uncertain, due to the surprising or soft character of the change, there is an active spatial intervention needed. Change does not occur by itself here, but when we need another outcome we need to plan for something else. Otherwise traditional planning processes take over and history will be repeating itself. An old Groningen saying says: *'Als je doet wat je deed krijg je wat je kreeg'* (*'If you do what you did, you get what you got').* In other words if you want to change the outcome, for instance to accommodate uncertain changes, plan for something else. Do not repeat history, but protrude above the mass as 'away from the average' people (12) with creativity, counterintuitivity and originality. When change is required or threatening, the system needs to respond as swarms do, they can adapt their shapes, direction and speed under influence of one minor intervention and become fluid and adaptive. Therefore, we need to allow minor interventions with major implications in our spatial systems to create more resilient systems (13). These interventions can be human, ideas or spatial. The search for these interventions is difficult and requires a process in which

participants feel safe, out-of-the box thinking is stimulated and innovative solutions are cherished. Design charrettes are an example of such an environment (14).

4. Transformation and swarm planning

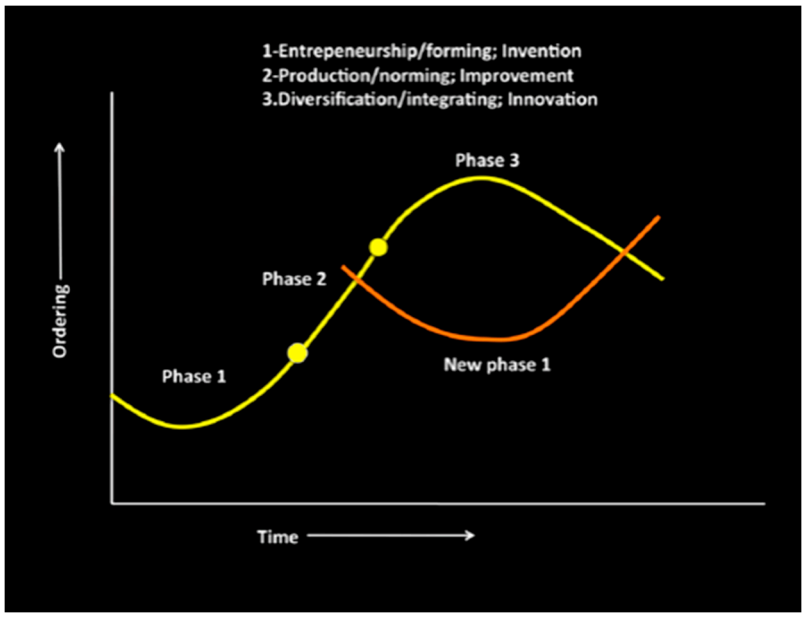
In order to prepare for change that cannot be predicted (Suddenism) or develops at a slow pace (Slow Urbanism), in other words everything but Fast Urbanism, a transformation does not occur by itself, but needs to be triggered by, for example, a minor intervention.

When the change is slow it requires a trigger to change the system. Learning from complexity theory, the system changes slowly and at a sudden moment the pressure finally becomes high enough to enforce the system change. In planning terms we could want to stimulate tis process, for instance when we think a development is sustainable but doesn't fully develop by itself. We could initiate a certain land use at a crucial spot, from where it is allowed to grow and influence its surrounding. In this case the spatial, urban system must be flexible enough to accommodate new uses and the desired changes.

In the case of Suddenism, the trigger is completely clear, namely the external influence, unexpected but strong, putting strong forces on the system, which will, due to these forces, undoubtedly change. However, most probably not into a desirable state, but in debries. In this case it is necessary to adjust the system in a way it is so flexible and adaptive it can accommodate the external trigger. Then we can speak of a resilient system. Also, this requires the spatial, urban flexibility in the system to adjust and adapt to, sudden, new uses and demands.

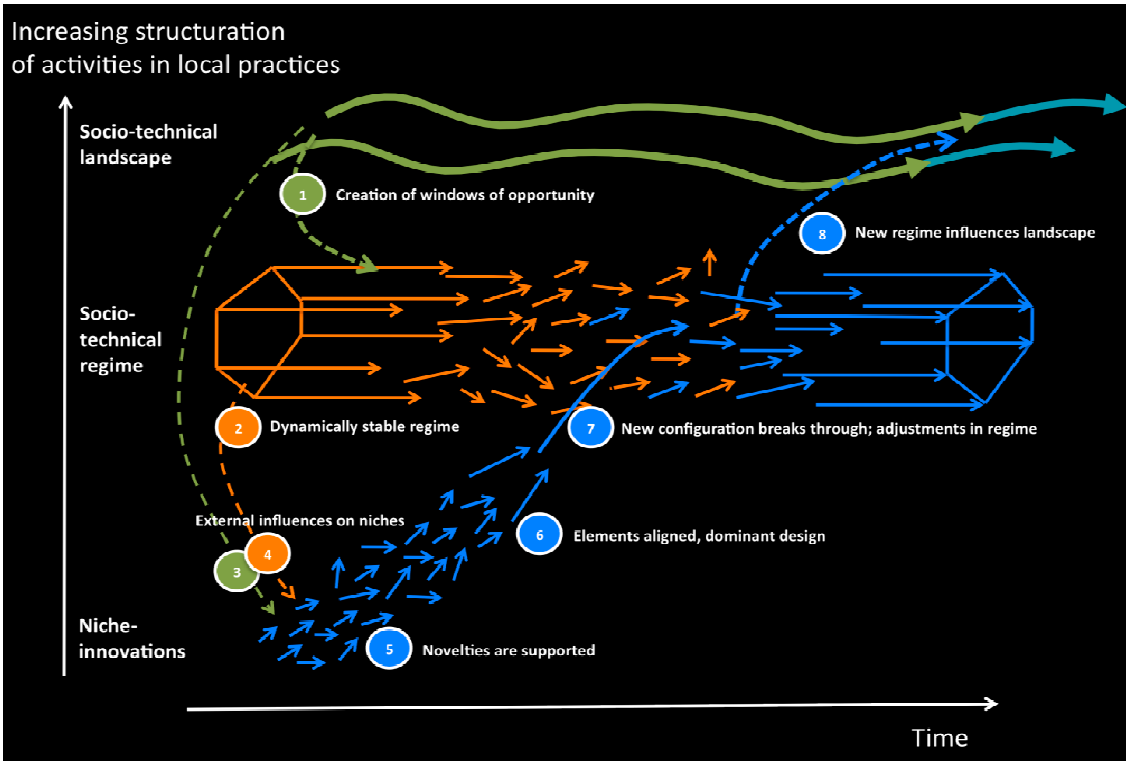
Both of these examples show the need for a flexible system, i.e. it can adapt to something unknown, hence it must contain the space to do so, and it needs a trigger to ignite the process of change. This would allow a transformation. Transformation, different from transition, implies a fundamental change of the system. In complexity terms, the system flips from one state to another. This process of transformation is first described by Ainsworth-Land (7) (figure 1).

Figure 1. The transformational process (after: 7).



Geels and others (2,3,4,5,6,8) describe how existing regimes get influenced by niche developments and trigger the system to flip (Figure 2), while Roggema, Vermeend and van den Dobbelsteen (11) emphasise the jump from the current pathway to an early version of a new system, represented by a second pathway.

Figure 2. Transformation of regimes under influence of niche developments (after: 3,6).



Each of these theories pay attention to the trigger that forces the system to transform, but they lack thinking about the (spatial) conditions of the system. Reflecting on the question: What is spatially required for a system to be capable to switch from one status to another, or when has a system the capacity to flip when needed. How can we define the spatial and functional capacity to change immediately (under influence of a certain impulse or trigger), or allow the change to slowly transform the system.

In Swarm Planning the capacity in the spatial system is combined with the intervention at a specific location in the network in order to instigate a spatial transformation, which enhances the capability to accommodate change. Swarm Planning learns from swarms in nature, which, in order to survive transform their shapes under influence of certain impulses. Similarly, Swarm Planning aims to

5. Application in planning

When we use transformation theory and swarm Planning in practice, the two types of change, Suddenism and Slow Urbanism, are further explored. Where Suddenism requires the capacity in the system to accommodate sudden change, Slow Urbanism requires a trigger to start the transformation before spatial chance in the system must be accommodated. Both end up putting a spatial claim on the urban space and if these claims can be combined, both can benefit from it as will the city itself. In order

to do so space must be seen as flexible in use and use is temporary to deal with both fast and slow changes.

5.1 Suddenism

The sudden impact of climate change imposes pressure on the spatial system which, in case there is no spatial capacity leads to a disaster. These impacts can vary from human indicated hazards (sea level rise, flood, bushfires to natural disasters, such as earthquakes or tsunamis. In this paper two cases are described: the Floodable Landscape of the Eeemsdelta and the Earthquake resilient landscape around Loppersum, both in the Netherlands. Both cases require the system to flip to a status where more spatial capacity can be deployed before or ultimately at the moment the impact occurs.

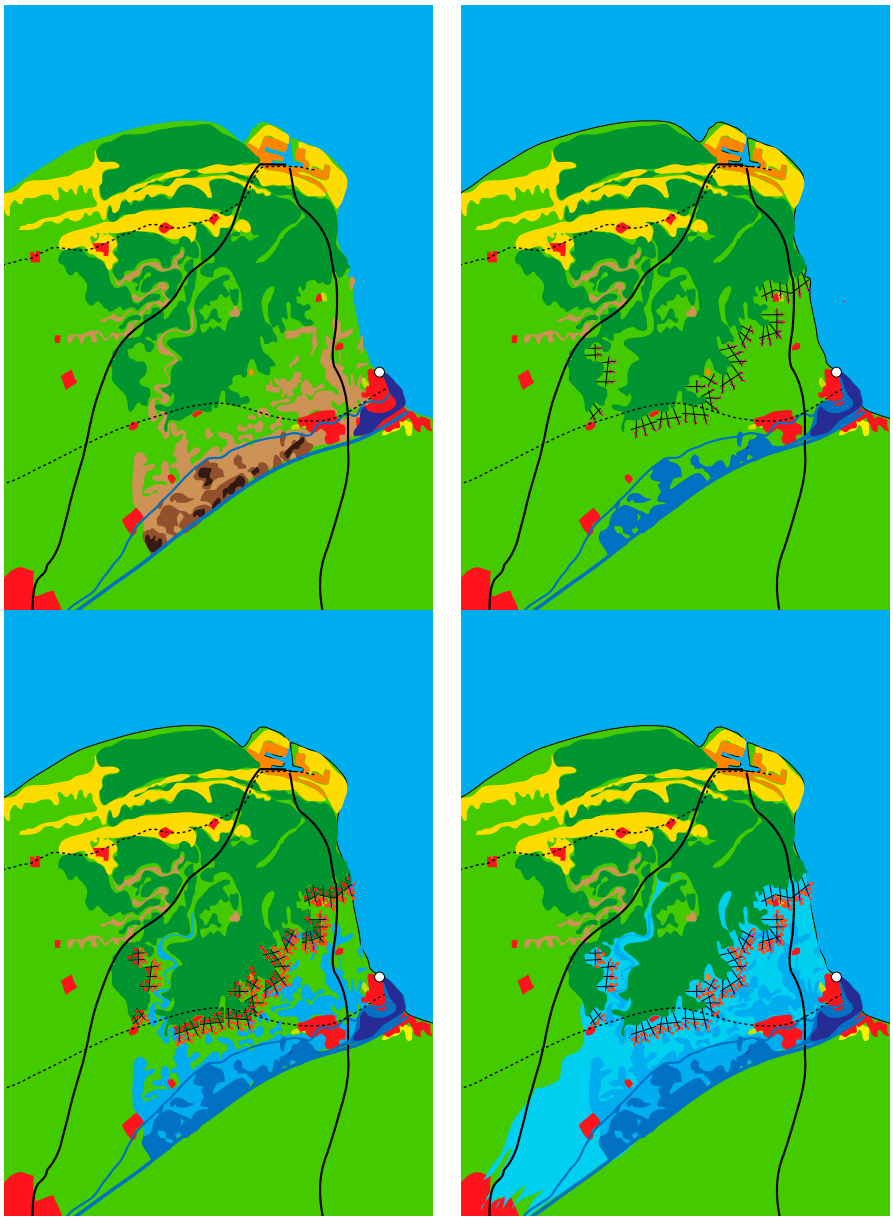
Floodable landscape of the Eemsdelta

The Eemsdelta area is vulnerable for sea level rise and storm surges, leading to potential flooding. The main response to this in policies and plans is to heighten the sea walls, which implies automatically that if the defence breaks the disaster is serious, will affect many people and economic values, and comes by surprise. In this landscape people and politicians better not wait for the trigger to bring them a disaster. The better option could be to anticipate uncertain future events. In the plan for the Floodable Eemsdelta this has been made manifest allowing the flooding to happen already hence bypassing the risk. Allowing the seawater already in the Hinterland the people have the time to get used to a rising sea level and an increasing amount of salty water in their environment. They are given the chance to adapt to these changing circumstances, and if they're smart they will adapt and create a more resilient landscape and community. The design consists of a couple of steps (figure 3). First the intervention is proposed to make a small hole in the dike, which allows the water to enter the landscape. The water will flow according elevation, i.e. when sea level is rising the water area extends to where the topography of the landscape allows it. When sea level increases to rise a bigger area will be covered by water. Understanding this process gives us the chance to anticipate future water in the landscape. In the design we therefore introduce artificial wooden structures, in between which the water is captured and sediment can be stored. This opens the possibility to attach houses that are capable to float, to the wooden structures. This results in a landscape with wooden structures and attached houses, which eventually will float, but only after the sea level has risen enough to cover these places in the landscape with water. In the case of the Floodable Eemsdelta the trigger of a sea level rise, culminating in a dike breach has been taken as a current intervention, hereby advancing future happenings. This made clear what requirements the landscape needed to fulfil and what an adapted landscape could look like.

Shock Support

The landscape of Groningen area in the Netherlands has to deal with a similar impact, only this is a natural disaster, an earthquake, which was instigated by human extraction of natural gas. Here, the landscape is vulnerable for gas extraction, as it has many different earth layers in the underground. These layers all react differently on gas extraction, which leads to surprising earthquakes in the landscape, affecting real estate and monuments in the area. So far, no casualties have been counted.

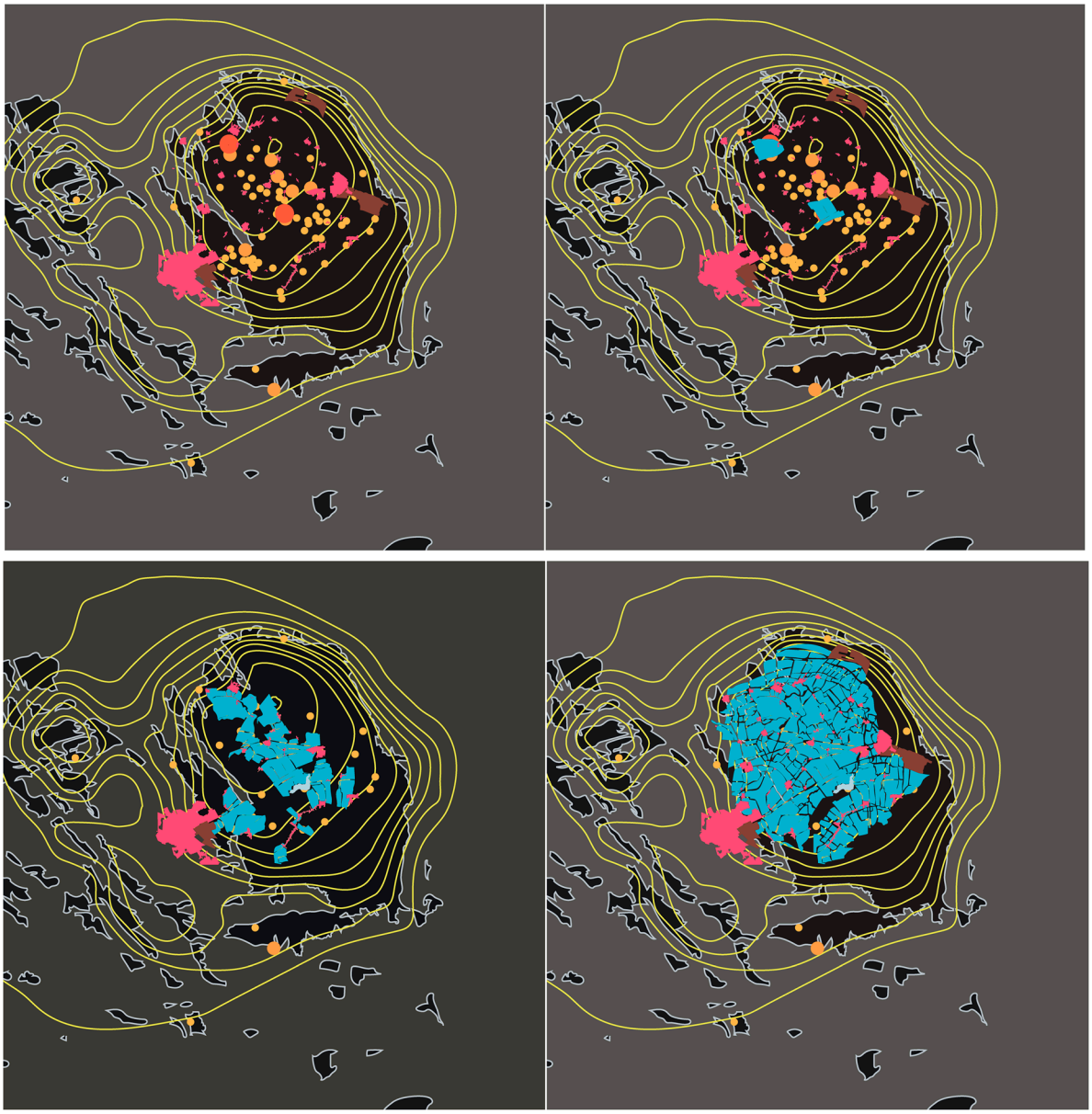
Figure 3. The Floodable Eemsdelta, design and intruding seawater in stages.



The proposed solution for the impact is to rebuild the houses stronger than before an earthquake, dispute the level of money available to leverage the peoples problems and to dispute the amount with which the gas extraction should be minimised in order to create a safe environment. These solutions all start from the perspective of solving problems afterwards, and keeping the risk at an earthquake intact. An alternative, Shock Support, however could be to think in bypassing the impact. When the trigger is an unexpectable quake, the living in the area should be made independent from this. In the landscape the houses require a treatment to become independent from a shaking underground. In the design proposal, each vulnerable house for an earthquake will be transformed into a small polder, which could be filled with water to create houses that will float. When the house is floating, it is independent from any earthquake in the future. When the first polders are provided in the most vulnerable locations, the entire landscape will be subsequently transformed into an archipelago of small and safe polders in stages (figure 4). The trigger of a surprising earthquake in the future has been used to transform the spatial use in the landscape, i.e. houses that are floating, independently from the earthquake. The landscape gets

separated from the risk, and is able to create a sustainable, attractive and foremost safe future for its inhabitants.

Figure 4. Design in stages for an Earthquake resilient landscape in Groningen.



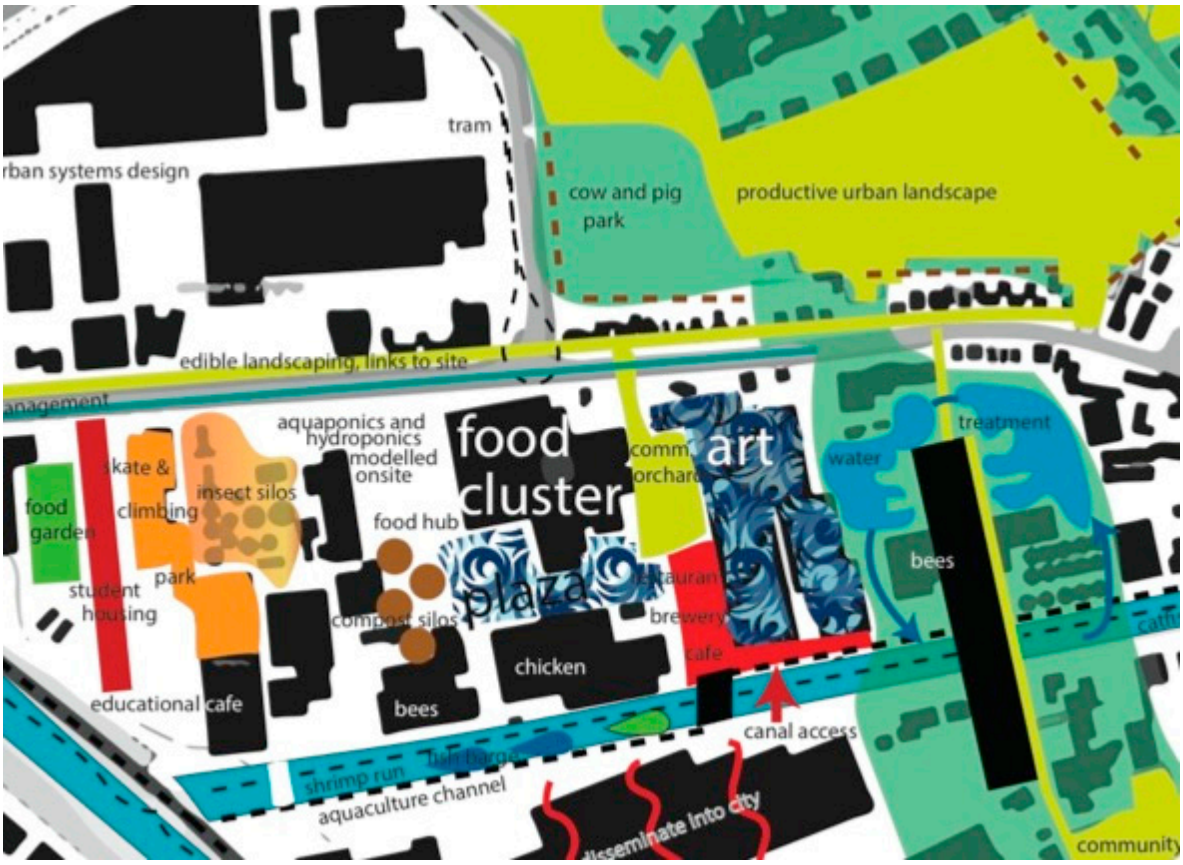
5.2 Slow Urbanism

In the case of Slow Urbanism a certain trend is impacting the urban land use for some time before (or if at all) it is capable to transform the urban land use. Often this is caused by existing, mostly long-term, decisions on land use and land prices or ownership. These existing commitments stand in the way of being flexible and allow changes of land use when there is a certain demand. In general, slow urbanism supports the development of slowly changing uses, such as the growth of food. This often requires a trigger before land use change actually will occur. In this section four designs illustrate how initial change can lead to a dispersed spread of alternative land-uses over the direct case-study area.

CHV-Noordkade, Veghel

The site in Veghel is an old industrial site for storage of wheat and corn, which is in transition to become a lively, multifunctional arts-, food-, and cultural hub in the town of Veghel.

Figure 5. The core of proposals in the heart of CHV-Noordkade.



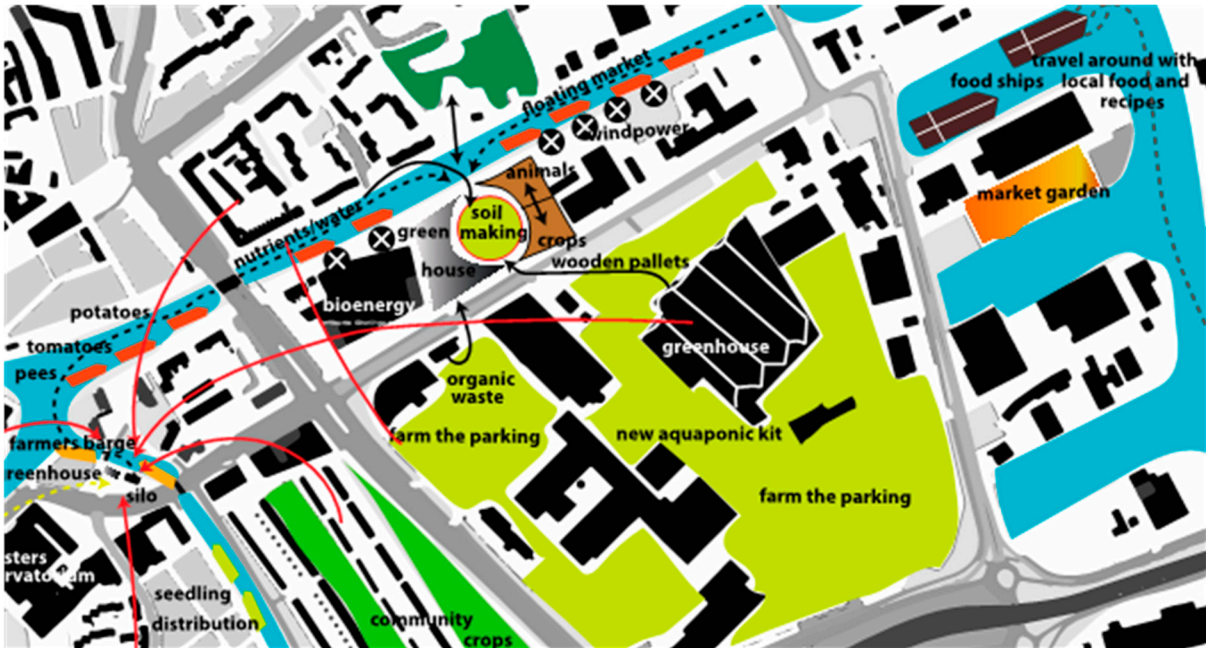
The accessibility and large scale of public spaces and building is seen as most important negative aspects of the site. The design proposes to establish a zero-food-miles zone and improve the connectivity. Connections by water are proposed, green corridors between the site and the countryside to provide exchange of green products and veining of productivity and economic activity into rest of the town. For the site itself a 'borough'-concept is proposed creating an urban environment where art, and culture and the growing of food go hand in hand. Rooftops, old silos and existing buildings are transformed into productive spaces. New, smaller buildings are added for residential and student housing, and to break the large scale into pieces. Productive spaces are located on and aside the canals (i.e. aquaponics, shrimp and catfish runs, and fish barges) and green rooftops, with markets operating on the water. The food cluster is extended with an arts precinct, a community orchard and café, tearoom, restaurant and brewery, with a craft brewery bar, and a skate-park. Visits are organised to the old storage spaces, the industrial heritage, and in, on and near the buildings industrial farming of fish, plants, worms, insects, bees, and small animals (chicken, rabbits) is foreseen. The initial change to transform the corn factory into an arts- and cultural hub made/makes other transformations possible and easier, such as growing food, education or other less viable uses. In the design it is clear the spaces are taken up by these uses subsequently and

at a slow pace. However, the space is becoming available because of the outdates role corn factories play in the area.

b. Graansilo, Groningen

This building, centrally located in the city of Groningen is a creative centre and hatchery for innovative businesses, such as the 'enervarium'. It is well connected with infrastructure with the countryside outside the city, but the site itself is somewhat isolated.

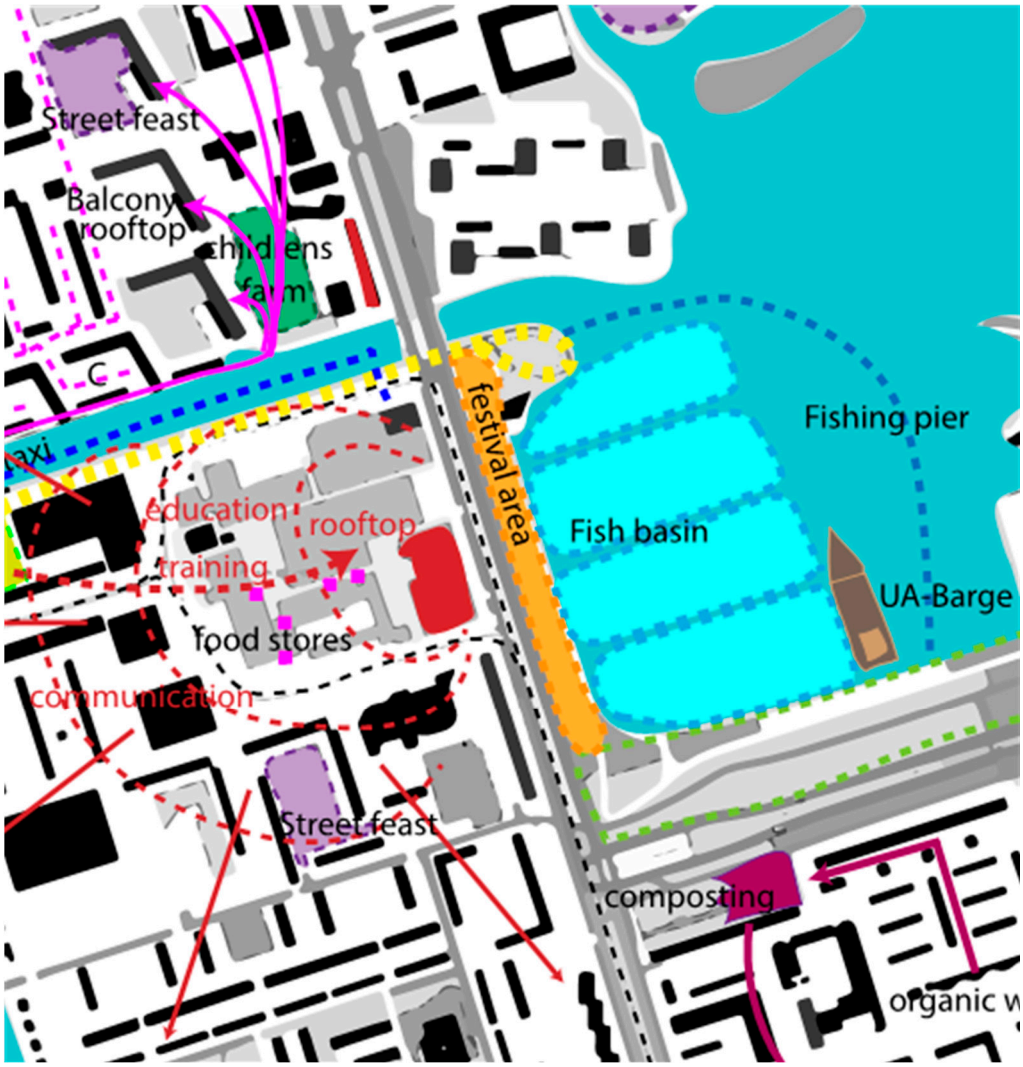
Figure 6. Graansilo as the initial point for expanding food initiatives towards its direct environment and beyond.



It is suggested to strengthen the industrial archaeology character of the area where historic ways of food processing can be connected with new techniques and processes. The site should be connected with the surrounding urban environment and the countryside, using food ships transporting people and food, create food ways/edible boulevards and streets, as continuous green connections. The wider area around the Graansilo is used for food production, on land, on roofs and on water, such as FoodRoofs, aquaponics, watercress, water gardening, greenhouses and more. Food waste from surrounding food factories is used to support roof-salad growing. The Graansilo is also seen as suitable to develop a cultural agenda, including hipsters, different groups of artists, artists in residence, creating multicultural food festivals and -events about the future of food at local, regional, national, even higher scale. In this agenda the Graansilo itself becomes a gastronomic centre point and water-based meeting point to learn and experience food. In this case the slow growing Food for the City movement imposes pressure to create spaces for these uses. The trigger to start realising these uses is the Graansilo itself, which operates as an incubator for new food concepts, such as own brewery, hop-growing and pigs and chicken farming. From here barges with food-markets, additional spaces on roofs of industrial sites and more are under development and increasing the space for food production in the city.

c. Meervaart, Amsterdam

Figure 7. Urban Agriculture components in the Meervaart area.



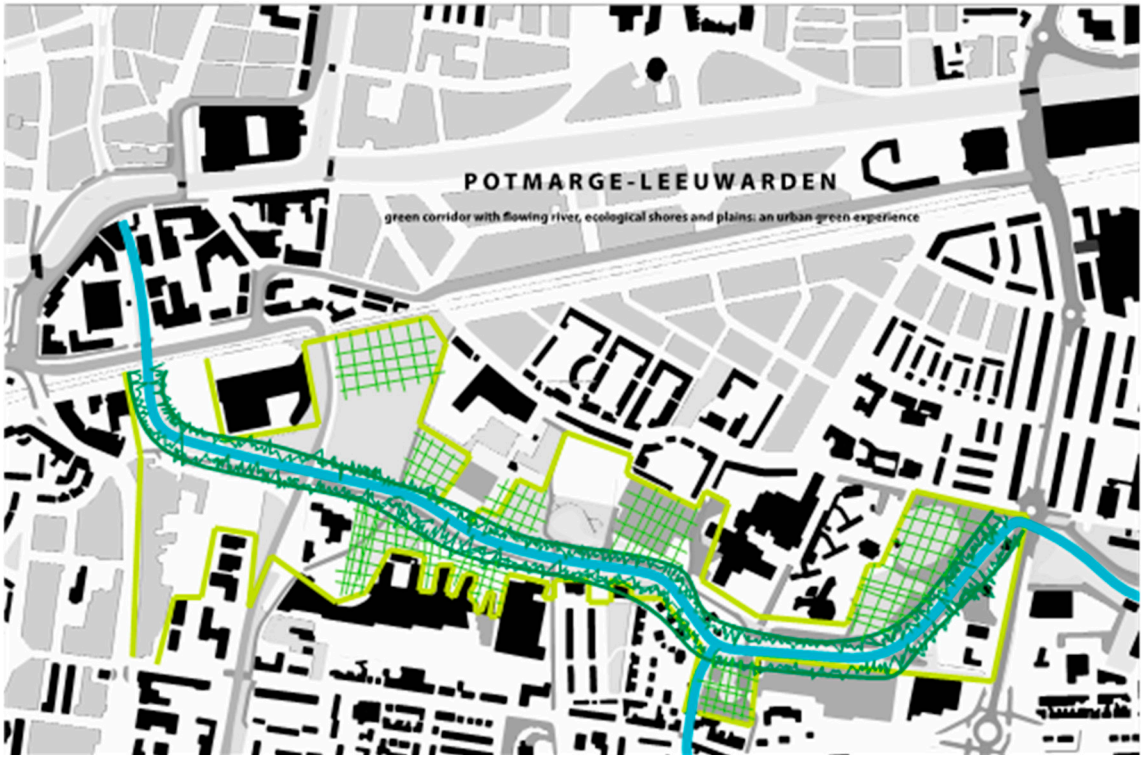
De Meervaart is a relatively old theatre in the western suburbs of Amsterdam. After a flourishing period at the end of last century, the theatre and nearby shopping centre are a bit on their return: a good reason to rejuvenate the area. This design proposes to position the Meervaart as the heart of an Urban Agriculture zone in the neighbourhood and beyond. On the rooftops of the Meervaart and the buildings in the neighbourhood green gardening, aquaponic systems and communicative activities are foreseen. The products can be directly sold to the Meervaart café and restaurant and other small restaurants in and nearby the shopping centre. These rooftop gardens can be exploited by locals who learn from local farmers, bringing in their farm knowledge to intercultural rooftop gardens, and the local producers can sell their produce at a local food market, shops and restaurants. Food establishes connectivity with people living in the vicinity of the theatre. The shores of the Sloterplas can be used as a productive space together with the lake itself where fish basins are proposed and an Urban Agriculture barge. The products can be used during the yearly food festival in front of theatre and at different street feasts taking place by surprise in the neighbourhood streets. The (rain-)water coming off public spaces and roofs is collected and reused on rooftops and balconies. Organic waste from these flats and public green is reversely

composted and re-used in 'symbolic' greenhouses located in public green. There are several green linkages proposed to connect the Meervaart with the rest of the city and the countryside, such as the Gardens of West, for instance through a river or canal taxi, which transports agricultural products and resources to and from the urban heart, but can also serves people. In the Meervaart case the redesign of the Meervaart roof, and the shore of the Slotervaart-lake as fish production spaces ignite the development of additional restaurants, eco-friendly water and energy systems and food production spaces in the rest of the precinct, even connecting the site with the countryside outside Amsterdam.

d. Potmarge-zone, Leeuwarden

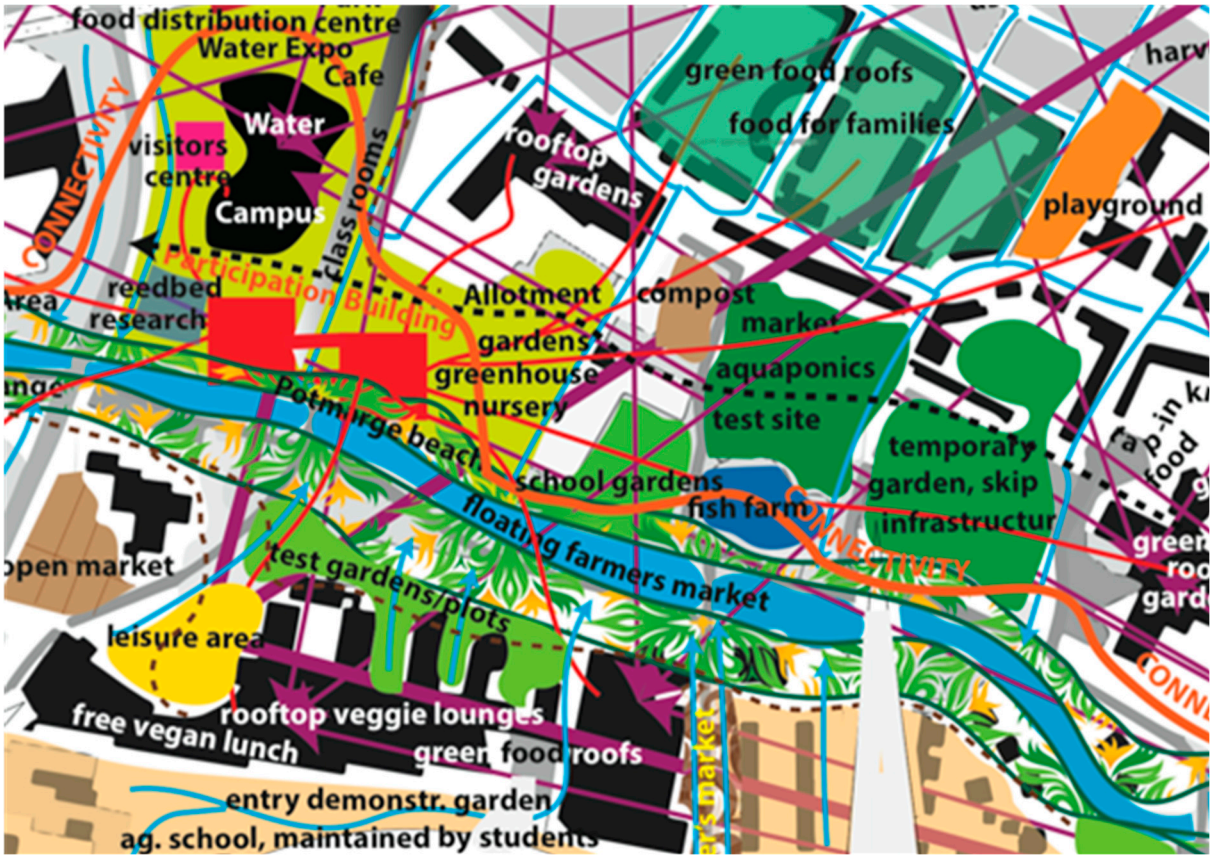
The Potmarge is an old river near the city centre of Leeuwarden along which a broad spectrum of land-uses appears. This has led to a somewhat messy area, urging for a certain restructuring and clarified spatial system. Accessibility, the schools as barriers and water quality are seen as the main issues.

Figure 8. The green boulevard, connecting the Potmarge zone with the city and forms linkage between all of the land-uses.



The main suggestion is to reshape the area as a Green Urban Boulevard of Leeuwarden (figure 8), where an important additional space can be created to grow food. This Boulevard is seen as a long connecting urban structure, which consists of the river itself, its shores he productive zones around it with continuous bike paths, footpaths and ecological corridors. It primarily connects the city centre with suburban Leeuwarden, but can also be seen as a loop when completed as a circle along the Nieuwe Kanaal in the North. It is a connection of experience, experiment and learning for fun, relaxation, innovation, creativity and eating local produced food.

Figure 9. Urban Agriculture in the Potmarge-zone.



The ambition is to increase the value of the Potmarge-zone through transforming the area in an aesthetic 'foodscape' (a productive food-landscape) both in the public as civic space, and consume only organic food produced within 50 km from the area. A range of thematic gardens fit in the Boulevard concept: sensorial gardens for rehabilitation purposes, edible schoolyards, a University farm for research, rooftop farms and greenhouses, atop institutional buildings, aquaponic systems, and rainwater harvesting systems. In the surrounding neighbourhoods the rooftops are used for PV/solar energy harvesting or aquaponics, edible streets are realised, coffee grinds is harvested for mushroom farms. The Potmarge is corked with a series of floating gardens and green markets, under which floating farmers markets, floating fish and veggie barges are located. The initiation of the Green Boulevard is in this case study the trigger to allow for more space to grow food, as spin-off of this green establishment, more local projects in the field of food, ecology, and education are given the space to be developed.

In every case study there is attention for the larger scale and connectivity with the rest of the city or town and the countryside. Further are water (floating markets, productive barges, aquaponics), use of green rooftops, closing cycles of water, energy, nutrients and materials, and the accessibility of the site major issues. In table 2 the most important subjects in each of the case studies are summarized.

6. Towards a new planning discourse?

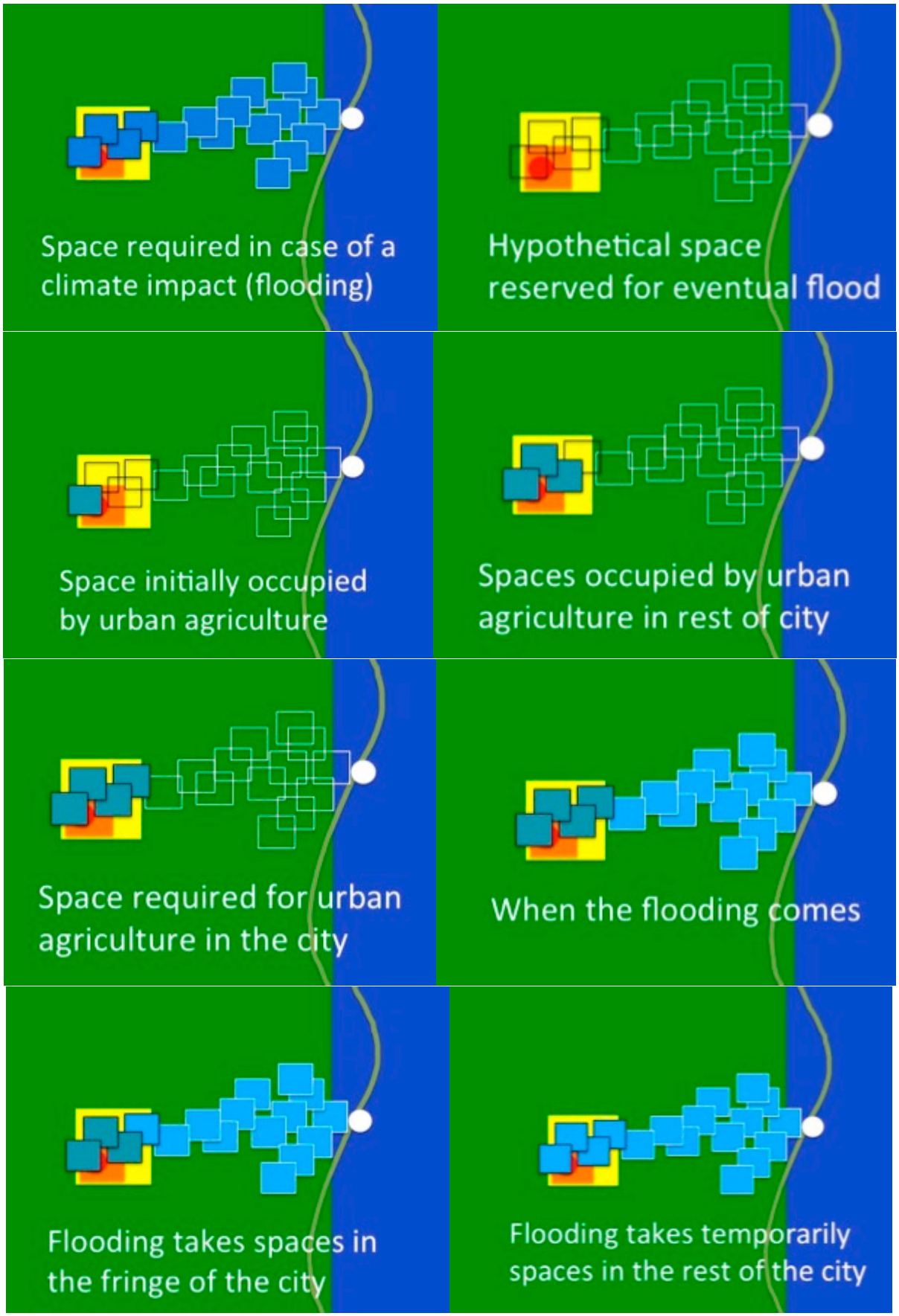
Categorising the plans: the Shake Support and Floodable Eemsdelta are characterised by their impact/trigger that influences the landscape, the settlements and the typology of buildings. The landscape, in which a lot of water will be accommodated, the settlements, which are supplemented with

additional built structures and system, which on their turn are adapted to the new surrounding landscape in which periodically large amounts of water is captured. The trigger is influencing the entire landscape, while the spatial uses in the landscape need to be made flexible for changing uses. On the other hand Slow Urbanism examples show a steady search for new urban spaces, from the initiating spaces, towards the immediate surrounding precinct and its connection with the urban fringe and the surrounding landscape. When these pilot design characteristics are brought together, a new planning discourse might emerge. A systemic approach to anticipating a disaster and the implications this might have for spatial uses in the city, which are to be more flexible and temporary. The spaces that are thus created from the contra-model of the required use from a Slow Urbanism perspective. Here, the first spaces occupied by the slow urbanism, i.e. food growing, are the spaces that should be made flexible from a Suddenism point of view. When the demand for more spaces increases, there is more temporary space to be occupied by these new uses, ultimately all spaces will be occupied by new, slow urbanism, uses. When the influence of the sudden (climate) impact occurs these spaces need to be able to be used for climate impacts (water storage, green space, etc.). This interaction between space occupied for slow uses and the sudden but temporary use in case of a disaster is represented in eight steps (Figure 10). After the occupation of temporary space, the water withdraws and urban spaces return to their original uses.

Table 2. Summary of key characteristics of Slow Urbanism case studies.

Leeuwarden	**Veghel**
• Comprehensive food-landscape • River Potmarge • Connectivity • Rooftops • Aquaponics • Stakeholders • Education • Accessibility • Biodiversity, ecology • Organic food • Floating markets • Tactile landscape, sensuality	• Linkages with other areas through greening • Aquaculture canal • 'Foodhub', integrating culture and art • Aquaponics • Rooftops • Stakeholders • Productive barges • Industrial heritage • Broad spectrum program • Zero-foodmiles area • Food landscape • Bees
Amsterdam	**Groningen**
• Rooftops & Balconies • Aquaponics • Experimentation and learning • Stakeholders • Food feasts, street market • Connectivity • Fish basin, UA-barge • Local products for local restaurants • Reuse wastewater • Recycling water, organic waste, composting • Accessibility and links with areas outside urban	• Industrial archaeology • Accessibility • Floating, farmers market • On water food growing • Aquaponics • UA-Barge • Recycling • Continuous green connections • Arts and culture, hipster and creativity • Food festivals • Hop plantation and beer brewing • Seedlings • Bees

Figure 10. Step by step animation of interfering spatial use between Slow Urbanism and Suddenism.



The combination of slow urbanism and Suddenism opens the way to using space for purposes whenever they are necessary. The space used depends on the necessary capacity in times of expected disasters in combination with the suitability for slow developing uses, such as urban agriculture. In plain design and planning terms, the space required to accommodate climate impacts can be used in general for uses that have difficulties of being planned, the so-called slow uses. The planning category of these spaces should be called temporary use, or multifunctional uses and can eventually be made specific as, for instance, urban agriculture with temporary use as flood storage basin.

7. Results and Discussion

The results of this study show that in order to create smart cities, nature could lead us the way. If we use the principles of swarming we can identify the urban interventions and pattern development of cities, and the way space is created for unexpected uses. In particular the capacity of space in the city is subject of study, because it could provide the flexibility in the city to accommodate the sudden demand for space in case of a disaster while it can be used during other periods as space for 'weaker' uses, such as urban agriculture. Swarms learn us to adapt to sudden external influences. This consists of two elements: a sudden impulse and the spatial freedom to change shape. Translated to the urban design context, the impulse given can be artificially induced, as an active human intervention, while the capacity of the system to use space for the following impacts can be designed in any urban design. However, this capacity is invisible at first, because the disaster only appears when it is happening, too late to prepare the city. Therefore the increase of spatial capacity for sudden demands must be created in the form of freely available space in the urban fabric. This is costly and only temporarily used space, so very unlikely to be part of the normal urban programming. But when this necessity is combined with slow urbanism, i.e. the slowly emerging demand for a certain use, generally weak economic forces, such as urban agriculture, public green or ecology, the space required for these uses can be temporarily utilised when the impact of a disaster must be accommodated.

The analysis of two Suddenism designs for climatic impacts (Floodable Eemsdelta and Shock Support) and four Slow Urbanism designs for Urban Agriculture respectively, shows this mutual benefit. When there is no climatic impact that requires space, public spaces can be used by these weak economic functions. To start realising these functions a starting point of departure needs to be created. One ore point in the urban fabric that is especially suitable for this use transforms as a form of eco-acupuncture (15,16), its use from a traditional urban function into an ecological, sustainable use. The four design cases show that once there is a certain core developed and supported, the other initiatives follow and can find their space in a follow up spatial programming. When the climatic impact needs to find a place to go somewhere in the urban environment, these areas are suddenly changing their use from urban agriculture or nature into water storage.

The pace of change is essential for the way, how to respond in urban design. When change is pressing and economically driven, the response is well known in the form of a Masterplan, which makes new land use possible. But when the pace is slow, and weak uses demand space it is less clear how their requirements could be met. Also, when change is sudden, there is often not counted on the impact in the capacity of the city and a disaster is born.

When Slow and Sudden change are, however, combined, a new planning discourse starts to emerge. The impact of a disaster claims certain space in the landscape and urban context. The locations this demands are identified using the natural emergent development of adaptive systems, or the way how a disaster might disperse through the landscape, meanwhile claiming spaces along the way. Especially in the case of flooding these places are easy to define, as the water generally flows there where the lowest points in the landscape are. On the other side the slow emergent claim of weaker uses requires careful acupuncture in existing urban environments, as the starting points for further emergent development of these weak uses across the city. When these spaces are established as urban agriculture, nature or else, they can offer the space in case of an emergency for instance when water needs to be stored in case of a flooding.

This way of planning is not regular. It deviates from the regular planning practice, because spatial use generally allows only one type of use for a certain space. In the case of a combinatory of uses the planning system must allow temporary uses and/or a shift in use over time. This is not very common and gives some juridical complications, as users may want to have certainty about the allowed uses in their environment and do not want to live in uncertainty.

8. Conclusion

The findings in our study comprise different aspects of planning for change. First of all, for different types of change a different urbanism is found necessary. It makes sense to divide change in fast, slow and sudden, and develop planning approaches accordingly: Fast Urbanism, Slow Urbanism and Suddenism.

Fast Urbanism changes land-use permanently, it is economic driven en has its own driving forces, generally economic. The spaces are transformed into another use, because that is more economically viable. On the contrary, Slow Urbanism is not economically driven, but a societal desired change. This implies it is not automatically taken up as part of the spatial program in a planning process, but requires a certain artificial support to claim the space desired, for instance by government regulation. This could initiate the development of these weaker and-uses, such as for instance urban agriculture or ecology. Once it has proven relevance, this type of land use could gain importance and further develop new areas, all in a slow pace. The spaces this type of land-use occupies could also be used temporarily for the impact of a climate impact or disaster, Suddenism, which is a type of urbanism that requires sudden and temporary land-use, as a result of sudden (climatic) changes.

When change is slow or sudden the amount of space required to accommodate these claims is also uncertain. This is generally also the reason why these developments are not part of regular planning processes, and more than once neglected. However, Slow and Sudden change share one characteristic, the need for flexible use of space, and here the two can find each other. In times without disaster space can be used for the so-called weak land-uses, while these spaces can be temporarily occupied when a disaster takes place. The case study designs illustrate the driving forces behind these two forms of urbanism. Slow Urbanism needs a momentum change or intervention to start the further spatial development as an emergent sprawl over the existing urban environment, while the impact of a disaster-like trigger demands the spatial conditions in places that need to become available. Combining these two

leads to a breathing city, in which inhaling allows the disaster to find its necessary space and exhaling pushes this use out and replaces it by productive other uses.

Research by design is a valuable way of investigating the different pro's and con's of spatial demands resulting from the differences in change. When change is slow, the spatial claims are different, but can be used to respond to Suddenism at the same time. These findings were brought to the fore by designing potential solutions, both for forms of Slow Urbanism as well as Suddenism. Explorations in urban contexts highlighted the developmental strengths and potentials when introducing a so-called weak land use, while the design of landscapes under threat of sudden change made their spatial requirements clear. AT a conceptual level these two drivers for design could then be combined in one coherent philosophy, but requires further design research.

Nature is in these cases used as a guiding principle. The understanding of swarm and flocking behaviour helps to mimic the changes in spatial condition to deal with the impacts of a natural or climatic disaster, while emergence, as a property of an adaptive (ecological) system, allows to build on a slowly growing use of the weaker land-uses, such as urban agriculture.

A smart city must be more than a technocratic data-aided urban environment (the infrastructural technocratic hardware of the city). It requires also the human scale and natural components (the software of the city) to be a complete city. Nature in itself is a smart system, and when we use the rules of nature when designing the city we can integrate both aspects of a smart city: the data-driven and the slow pace and sudden city. Especially because the rules of nature open up the potential of the city not only to be directed by efficiency and logic, but also by irrationality, autonomous change and emergence.

Conflict of Interest

The authors declare no conflict of interest

References and Notes

1. Roggema, R. The reinvention of the academic conference: how active delegates develop productive city concepts. *Future of Food Journal,* **2015,** *1* (forthcoming)
2. Rotmans, J.; Kemp, R.; van Asselt, M.; Geels, F.; Verbong, G.; Molendijk, K. *Transities en Transitiemanagement: De Casus Van Een Emissiearme Energievoorziening;* ICIS: Maastricht, The Netherlands, **2000**.
3. Geels, F.W. Technological transitions as evolutionary reconfiguration processes: A multilevel perspective and a case study. *Res. Policy* **2002**, *31*, 1257–1274.
4. Geels, F.W. Processes and patterns in transitions and system innovations: Refining the co-evolutionary multi-level perspective. *Technol. Forecast Soc*. **2005**, *72*, 681–696.
5. Geels, F.W. The multi-level perspective on sustainability transitions: Responses to seven criticisms. *Technol. Forecast Soc*. **2011**, *1*, 24–40.
6. Schot, J.; Geels, F.W. Strategic niche management and sustainable innovation journeys: theory, findings, research agenda and policy. *Technology Analysis & Strategic Management*, **2008**, *20* (5), 537-554
7. Ainsworth-Land, G.T. *Grow or Die. The Unifying Principle of Transformation*; John Wiley & Sons: New York, NY, USA, **1986**.

8. Geels, F.W.; Kemp, R. Transitions, Transformations and Reproduction: Dynamics of Socio-Technical Systems. In *Flexibility and Stability in Economic Transformation*; McKelvey, M., Holmén, M., Eds.; Oxford University Press: New York, NY, USA, **2006**; pp. 227–256.
9. Roggema, R. Swarm Planning: A New Design Paradigm Dealing With Long Term Problems Associated With Turbulence. In *Business Planning for Turbulent Times, new methods for applying scenarios* Ramirez, R., Selsky, J.W., Van der Heijden, K., Eds.; Earthscan: Abingdon, UK, **2008**, pp. 103-129
10. Roggema, R.; Stremke, S. Networks as the Driving Force for Climate Design. In *Swarming Landscapes: The Art of Designing for Climate Adaptation* Roggema, R., Ed. Springer: Dordrecht, Heidelberg, London, **2012**, pp. 91-116
11. Roggema, R.; Vermeend, T.; Van den Dobbelsteen, A. Incremental change, transition or transformation? Optimising change pathways for climate adaptation in spatial planning. *Sustainability* **2012,** *4,* 2525-2549
12. Ridderstråle, J.; Nordström, K. *Karaoke Capitalism* Pearson education Ltd., Harlow, UK, **2004**
13. Roggema, R. *Massive change with minor interventions.* Environmental Innovators Symposium New Programs and Leaders in Times of Massive Change. Tokyo- KEIO University, Hiyoshi campus, 4 March **2015**
14. Roggema, R. *The Design Charrette: Ways to Envision Sustainable Futures*. Springer, Dordrecht, Heidelberg, London, NL/Germany/UK, **2013**, 335 pp
15. Ryan, C. *Eco-Acupuncture: Designing Future Transitions for Urban Communities for a Resilient Low-Carbon Future*. Proceedings of the State of Australian Cities Conference, Melbourne. http://www.soac2011.com.au/ **2011**
16. Ryan C.; Biggs, C.; Trudgeon, M. *Eco-Acupuncture and Greenaissance: Designing urban interventions for resilient post-carbonaceous futures, from Victoria (Australia) to Florence (Italy).* Proceedings of the State of Australian Cities Conference, Melbourne. http://www.soac2014.com.au/ **2014**