



Article

Scenario Archetypes: Converging rather than Diverging Themes

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Abstract: The achievement of a less unsustainable future requires a multi-dimensional approach that addresses a range of 'issues' (i.e. the sustainability indicator spectrum; demographics through to water) within a bounded 'space' (i.e. global through to local scale) over 'time' (i.e. current and future generations). Future scenarios provide challenging, plausible and relevant stories about how the future could unfold, typically over 5 to 100 years. As neither forecasts nor predictions and unconstrained by the requirement for substantiating how one gets from here to there they allow a range of sustainability issues to be challenged at different scales in future worlds. Urban Futures (UF) research has identified a substantial set (>450) of seemingly disparate scenario visions published over the period 1997-2011. In so doing a substantial evidence-base for convergence of themes is identified from which distinct scenario archetypes could be drawn. This is a distinct advantage those who wish to test the principles of sustainability against a generic scenario set, rather than derive yet more scenarios to add to the list already identified. In this research, a sub-set of >160 scenarios have been identified and categorised based on their

narratives according to the structure first proposed by the Global Scenario Group (GSG) in 1997: three world types (Business as Usual, Barbarisation, and Great Transitions) and six scenarios, two for each world type (Policy Reform - PR, Market Forces - MF, Breakdown - B, Fortress World - FW, Eco-Communalism - EC and New Sustainability Paradigm – NSP). It is suggested that four of these (MF, PR, NSP and FW) are sufficiently distinct to facilitate active stakeholder engagement and are accompanied by a well-established, internally consistent set of narratives that provide a deeper understanding of the key fundamental drivers (e.g. economic, environmental, social, technological, political and organisational) that could bring about realistic world changes through a push or a pull effect. This is testament to the original concept of the GSG scenarios and their development and refinement over a 16 year period.

Keywords: keyword; keyword; keyword.

1. Introduction

The publication of the 1987 Brundtland report *‘Our Common Future’* by the World Commission on Environment and Development energised the concept of sustainable development and prompted the commitment of world leaders at the 1992 Earth Summit in Rio to development that “meets the needs of the present without compromising the ability of future generations to meet their own needs.” Undoubtedly these events helped place the sustainability agenda at the epicentre of national and international policy and research for the last 25 years. During this time it has been suggested that three dimensions are required to adequately address sustainability: *‘issues’* (i.e. the sustainability indicator spectrum from demographics to water); *‘space’* (i.e. international scale, different countries and regions); and *‘time’* (i.e. future generations, their needs and aspirations). ‘Urban Futures’ (UF) scenario-based research (www.urban-futures.org) is a four year EPSRC funded project tasked with testing the resilience of today’s sustainability solutions considering a diverse range of issues (biodiversity, air quality, water, energy, underground infrastructure, built environment, density and decision making, organizational behavior and innovation, enterprise and social needs, aspirations and policy) within UK urban regeneration sites, assuming a time step of 40 years hence (the approximate length of time for a regeneration cycle). Future scenarios in this case are not forecasts or predictions; they are however plausible, challenging and relevant stories about how the future may unfold [1-4]. The first step of UF research was to identify and review existing futures studies (a forthcoming monograph by Hunt et al., [5] identified >450 distinct scenarios variants since 1997) and then investigate whether a distinct set of archetypal visions could be established. The starting point for this paper is to investigate the robustness of a set of archetypal visions first proposed by the Global Scenarios Group (GSG) in 1997. Conclusions are drawn as to whether the GSG scenarios might be adopted and refined for UF research that is UK-based, rather than necessitating the derivation of yet another set of scenarios.

1.1. Contextual history of GSG

In 1991 a collaboration between the Tellus Institute and the Stockholm Environment Institute explored the following high-level research questions as part of the PoleStar Project (www.polestarproject.org, [6]):

1. What approaches and methods are appropriate for examining long-range socio-ecological prospects in a coherent and scientifically-grounded way?
2. What policy adjustments in the near term are necessary to assure a vibrant and verdant civilization for the future?
3. What are the implications for our values, behaviours, and lifestyles of taking seriously the concern for the well-being of people who are distant in space and time, and of the wider community of life with whom we share the biosphere?

This research resulted in the development of the polestar system, a flexible tool for quantification of integrated alternative long-range scenarios at regional, national and global scales. In addition it provided detailed data sets (parameters relevant to economy, society, resource use, and environment) which, combined with the richness of scenario narratives, provided a robust methodological framework for considering fundamental shifts in global development - including discontinuities and restructuring of socio-ecological systems [7]. To carry on this legacy the Global Scenario Group (GSG - www.gsg.org), an interdisciplinary and international group with a pedigree of conducting integrated scenario assessments, was assembled in 1995 by the Tellus Institute and Stockholm Environment Institute. In 1997 Gallopin and colleagues first proposed a set of 3 plausible divergent world end-states [8]; referred to as Conventional, Great Transitions and Barbarisation to which a fourth was later added [9]; **'Muddling through'** – a passive majority on the grand question of the global future. Over a five-year period, six scenario variants (Table 1) were subsequently defined, refined and checked repeatedly for internal consistency [10,11]. In addition quantification of analysed data (using the Polestar system) was made available in a Technical document for four scenarios; MF, PR, NSP and FW, Table 1 [7], updated in 2009 using an additional 10 years of data and an expanding literature on environmental, resource, and social developments [6]. Two others (EC and B) were not quantified, presumably because of their extreme nature?

Table 1. GSG scenarios: 4 archetypal social visions for the future, adapted from [1].

World end-state	Scenario variants	Archetypal Social Visions
'Conventional'	Market Forces (MF)	A world that evolves gradually, shaped by dominant driving forces
	Policy Reform (PR)	A world that is influenced by a strong policy push for sustainability
'Great Transitions'	New Sustainability Paradigm (NSP)	A world where new human values and new approaches to development emerge
	Eco-Communalism (EC)	
'Barbarisation'	Fortress world (FW)	A world that succumbs to fragmentation, environmental collapse, and institutional failure
	Breakdown (B)	

In 2005 Raskin (president of Tellus) compared GSGs' visions of the future with five other well-reported scenario studies, WBCSD [12], OECD, [13-15], IPCC [16], UNEP [17,18] and WWF [19,20], and suggested that a common set of four archetypal social visions could be found [21], Table 1. Subsequently further mapping exercises have been conducted as more scenarios emerged [22-32], however, the world-end states (and scenario variants) first proposed by GSG continue were not tested to establish if they continued to form a distinct set of archetypal social visions. By combining prior knowledge from the literature and adding in further scenario variants (based on qualitative details given within scenario narratives) a substantially increased evidence-base is provided herein to support this hypothesis (Section 2). The legacy of the GSG scenario variants are subsequently discussed in the context of providing a distinct set of archetypal visions relevant to anyone considering scenario-based studies (Section 3). Conclusions are subsequently drawn regarding the credibility of archetypes drawn from the GSG work (Section 4).

2. Comparing GSG Scenarios Variants with those from the Literature

In this section each GSG scenario variant is outlined within the three world end-states; aligned to each scenario variant are the observations from the literature (shown in **Bold** in Table 2) that identify similarities with other scenario based studies. In addition to this observations are made during this study (Shown in *italics* in Table 2). Scenarios that fall under more than one category are listed under each.

2.1. Conventional Worlds

The first GSG scenario variant within the conventional world archetype is '*Market forces - MF*'.

'MF is constructed as a future in which free market optimism remains dominant and proves well-founded [33]'. 'Market-driven globalization, trade liberalization, institutional modernization - relies centrally on the self-correcting logic of competitive markets to address global challenges [21].' Populations and the global economy expand and free trade and deregulation drive growth. The availability of sufficient resources—raw materials, land, water, energy—and the means of maintaining ecological resilience in such a huge economy are critical uncertainties. The challenge of satisfying bio-physical sustainability constraints is compounded by the challenge of maintaining social and economic sustainability in a world of profound inequalities between rich and poor countries, and within each country [33]'.

'*Market Forces*' was originally referred to as '*Reference*' and '*Business-As-Usual*' scenario [8,10], the name '*Market forces*' came later [6,9,11] and supports generic worldwide application for each world end-state showing greater appreciation that, whilst MF may be based upon historical patterns and business-as-usual for the future in the US [6], it may not be a fair representation for a reference scenario everywhere.

Within the literature there are numerous scenarios aligning with the MF variant: Raskin [21] first suggested that the MF scenario was broadly similar to:

- First Raise Our Growth - *FROG!* - a familiar world where economic growth and success is a major concern and where human social systems are unable to meet the challenge of sustainable development, [12];
- '*Business as usual*' - a continuation and extrapolation of current trends with limited investment in water infrastructure, [19];
- '*Reference*' - a market forces approach based on current UN predictions, [13-15];
- '*AI*' - an integrated unsustainable world of very rapid economic growth [16], and
- '*Markets First*' - a world based upon market driven developments [17,18] (developed to '*Economy First*' [34,35], in which Globalisation and liberalisation are embraced, economic growth is high and multinational companies dictate environmental standards, the close relationship being shown in Figure 1b).

The compatibility between '*AI*' and '*FROG*' has been recognised previously by Morita et al., [36] and the strong links between '*AI*' and '*Markets first*' have been reinforced by numerous authors [23,24,26,32,37,38], based upon both having a strong global-economic-self-interest / reactive focus, a commonality shared by many of the scenarios described herein (Figure 1a,b and 2). As such '*Great escape*' and '*Global economy*' can also be added to the list. Figure 3 shows qualitative patterns for some of the previously mentioned scenarios according to a range of key drivers from where direct alignment with MF can be seen.

Figure 1. (a) 10 Scenario studies on two axes of uncertainty, modified from [26, 32]
(b) Approximate location of scenarios, modified from [34,35]

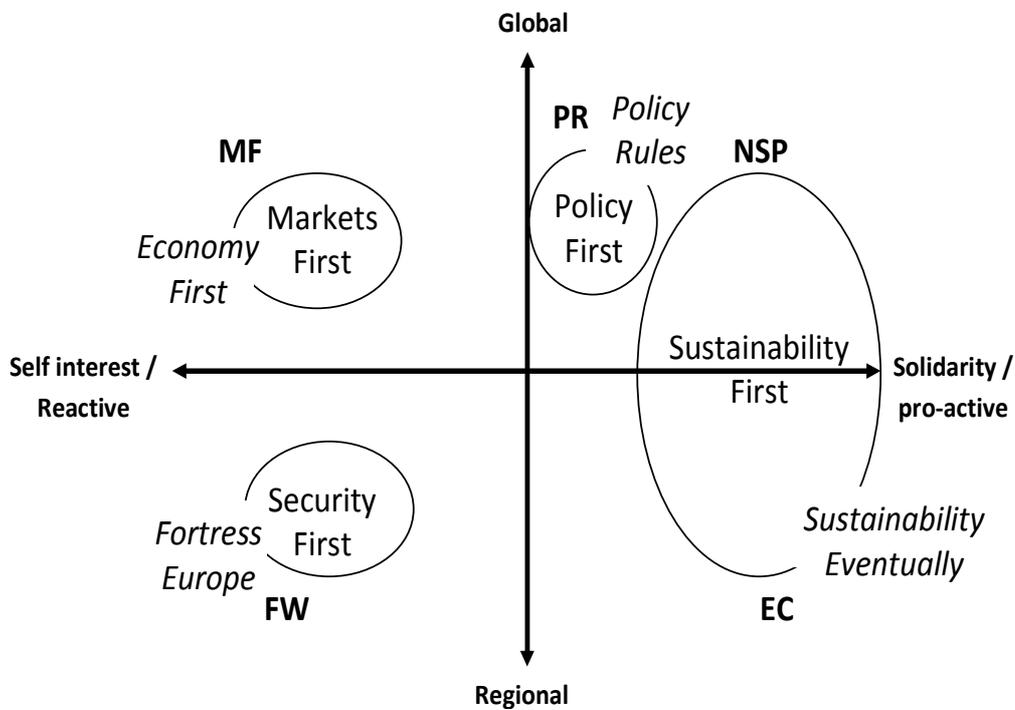


Figure 2. Various scenarios plotted against SRES axes, modified from [24] – scenario sets identified by matching shapes / text.

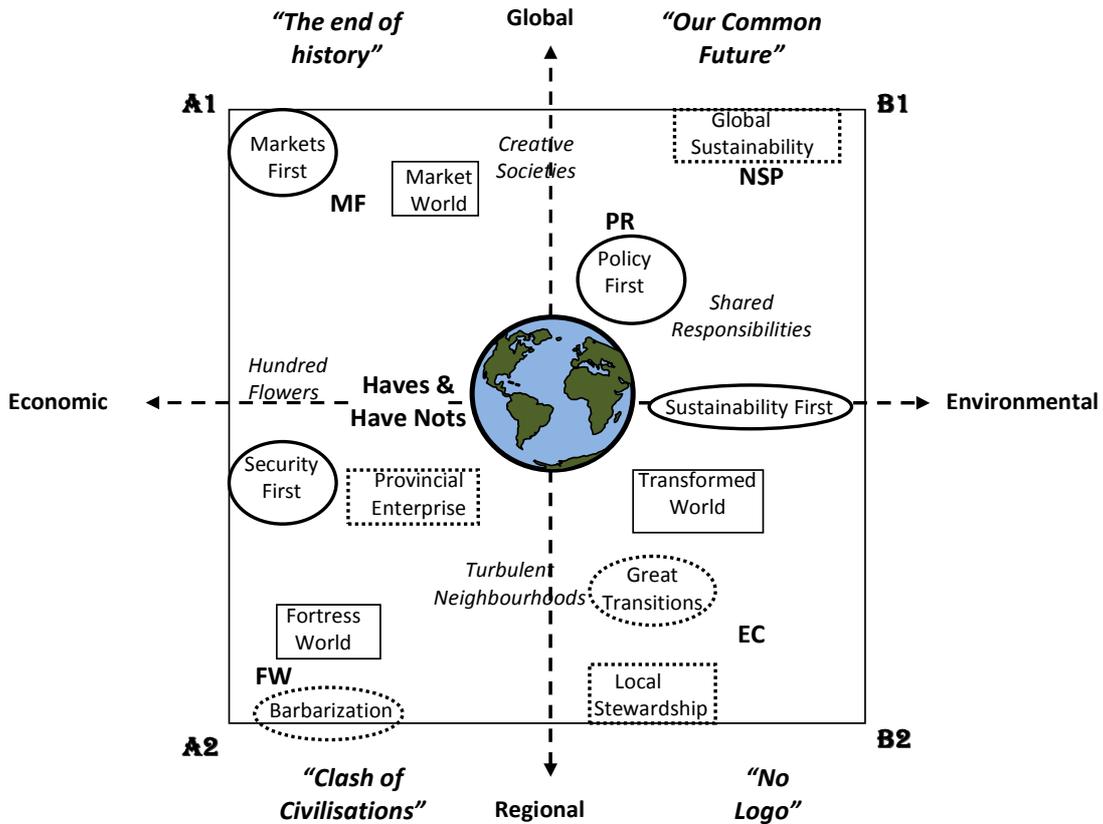


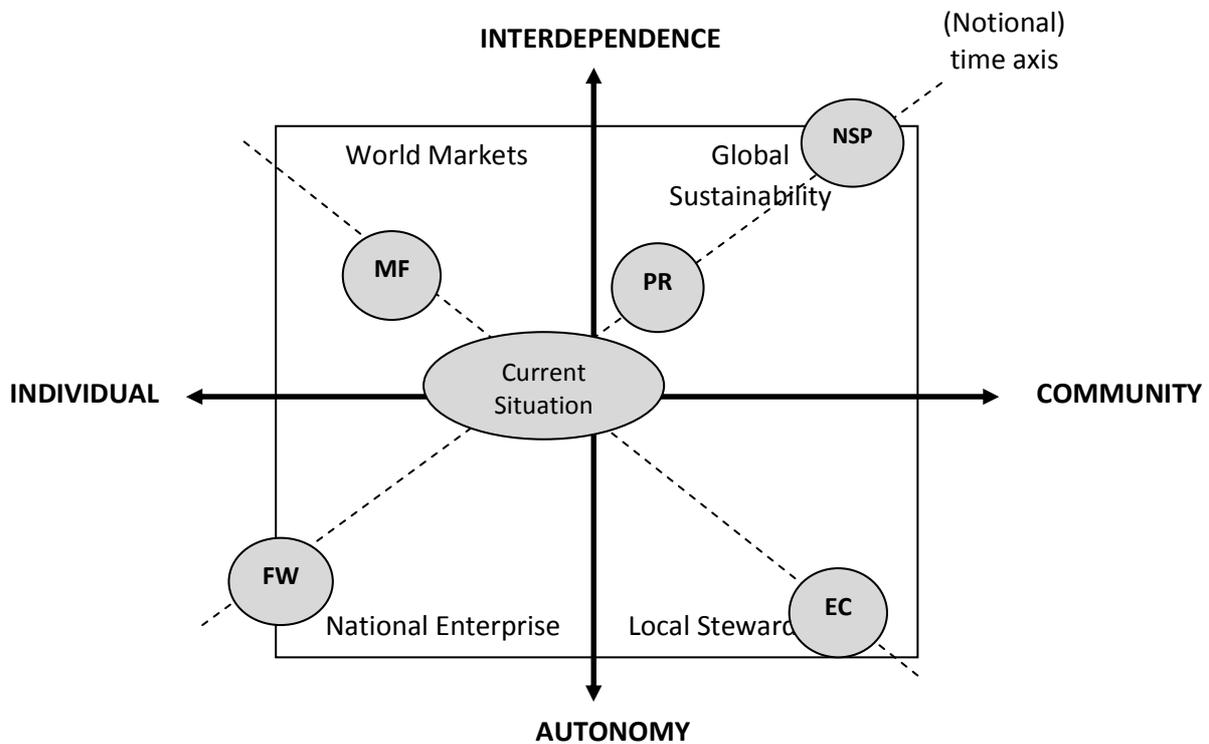
Figure 3. Qualitative patterns of change in MF according to key drivers, modified from [8,26]

Scenario	Population	Solidarity	Technology	Economy	Environment	Regulation	Globalization
MF (GSG)	↗	↘	→	↗	↘	↘	↗
A1	↗	↘	→	↗	↘	↘	↗
Markets First	↗	↘	→	↗	↘	↘	↗
Reference	↗	↘	→	↗	↘	↘	↗
Global Economy	↗	↘	→	↗	↘	↘	↗

Pridmore [22] has previously suggested a close alignment between ‘A1’ and ‘World Markets’, e.g. like USA [39] a world with consumerist values, global governance and declining manufacturing and agriculture [23,40,41]. The close relationship with MF is identified in Figure 4 [30] and is confirmed by Pinnegar *et al* [23], with the addition of ‘Market world’ [42], ‘Beta’ (An early version of EA’s ‘Jeopardy’ scenario), and ‘Global Orchestration’ - although the last of these has not been added to the list as it resonates more evidently with NSP (Section 2.1). Around the same time EA [27] reported close links between ‘World Markets’ (previously linked to many other MF type scenarios) and their ‘Jeopardy’ scenario (an intensive materialistic consumerist culture, coupled with high economic growth, growing social fragmentation and a continuing reliance on fossil-based fuels [27], a scenario upon which ‘Blinkered Evolution’ (a world where mainstream behaviour is committed to an individualised consumption paradigm [43]) was based. Taylor *et al* [28] confirms many of these

relationships and further suggests close resemblance between ‘*Market Forces*’, a scenario based directly on the work of GSG that assumes economic growth paradigms, based on the experience of developed countries, are appropriate for the rest of the world [25], and their ‘*New Frontiers*’ scenario, this is not surprising given the references therein to market competition, individual meritocracy, unfettered consumption, education and health for those that can afford it.

Figure 4. GSG scenarios within the Foresight Futures 2020 plain [30].



Several addition have been made to this list based on the adoption of similar descriptors and core values to MF, these are:

- ‘*Riding the Tiger*’ – a linear continuation of the current era [44];
- ‘*Triumphant Markets*’ – a world of materialism, consumerism, free trade and market integration, [45];
- ‘*World markets*’ – where material wealth and greater mobility is to the detriment of society and the environment [43];
- ‘*High growth (F-0)*’ – a throw away economy with a free market model [46];
- ‘*Go for Growth*’ – where economic growth continues to be driven by consumption and new technology [31];
- ‘*Growing on*’ – where high economic growth is at the expense of social cohesion and environmental sustainability [39];
- ‘*Perpetual Motion*’ – a society driven by constant information, consumption and competition [47];
- ‘*Carry on consuming*’ – where UK supply chains are dominated by a handful of companies and global competition has put greater reliance on production and processing within the European region [48];
- ‘*Bazaar*’ – a market world where free market policies, corporate restructuring and entrepreneurship offer a model for the rest of the world [49];

- ‘High emissions’ [50];
- ‘Market Forces’ – in this scenario the Environment Agency focus on growth, consumerism and high water demand [51] it is not surprising that this has been rebranded as ‘uncontrolled demand’ [52], a significant concern in the water field.

The second scenario within the conventional archetype is ‘Policy reform – PR’.

The PR path requires unprecedented political will for establishing the necessary regulatory, economic, social, technological, and legal mechanisms [33]. This strong policy is used to meet social and environmental sustainability goals following widespread concern over environmental deterioration, social conflict, and economic instability. This leads to a marshalling of political will to implement comprehensive government action aimed at redirecting and constraining the global economy to achieve a broad set of social and environmental goals [21]. PR assumes the emergence of a massive government-led effort to achieve sustainability without major changes in the state-centric international order, modern institutional structures, and consumerist values [33]. For example PR is assumed to have adopted the best available technologies and yet behaviour has remained relatively unchanged [6]. There is a deep and widespread commitment to economic equity and strong and harmonized policies are implemented that, by redirecting the world economy and promoting technological innovation, are able to achieve internationally recognized goals for poverty reduction, climate change stabilization, ecosystem preservation, freshwater protection, and pollution control [33].

Raskin [21] first suggested that PR was broadly similar to:

- Global Ecosystem Organisation – ‘GEOpolity’ – a world where an environmental and social crisis looms and the response is to build an interlocking governance structure coordinated at the international level, [12];
- ‘Technology, Economics and the private sector’ – where private sector initiatives lead research and development, and globalisation drives economic growth, but the poorest countries are left behind [19];
- ‘Policy variants’ – Decarbonisation is a major theme in this world, prompted by a carbon market in which all goods and services carry a carbon price [13-15];
- ‘B1’ (a world that emphasises global solutions to economic, social, and environmental sustainability with reductions in material intensity and the introduction of clean and resource-efficient technologies [16] , and
- ‘Policy First’ – where strong actions are undertaken by governments in an attempt to reach specific social and environmental goals, [17,18], developed to ‘Policy Rules’ where Europe is at the forefront of a new socio-economic paradigm of public/private partnerships and leads a global shift in direction, water framework directive compliance is higher than ever – the close relationship can be seen in Figure 1 [34,35].

The compatibility between ‘B1’ and ‘GEOpolity’ has been recognised previously by Morita *et al* [35] whilst correspondence between PR, ‘B1’ and ‘Policy first’ is reinforced by numerous authors [18,23,26,37,38]. In terms of high global-environmental-solidarity / pro-active considerations (Figure 1a,b, and 2) very close compatibility is reported between ‘B1’ and ‘Global sustainability’ [22,24]. This view is upheld by Busch [26] and Kok *et al* [32] with the addition of the following: ‘Technogarden, Knowledge is King, Big Crisis, Strong Europe and Global Co-operation’. As ‘Global Sustainability’ and ‘B1’ align with both PR and NSP, albeit more strongly in NSP, they appear in both lists (Table 2).

Figure 5 shows close alignment of previously mentioned scenarios to PR when considering qualitative patterns of change according to a range of key drivers [26].

Figure 5. Qualitative patterns of change in PR according to key drivers, modified from [8,26]

Scenario	Population	Solidarity	Technology	Economy	Environment	Regulation	Globalization
PR (GSG)							
B1							
Policy First							
Global Co-operation							

Whilst Makropoulos *et al* [30] suggests that PR is on the way to NSP, Raskin [53] argues that the transition very much depends upon where branch points [8] might form. Pinnegar *et al* [23] have aligned ‘B1’ with ‘Global commons’ (where people aspire to high levels of welfare and a sound environment, international co-operation towards global sustainability [23]); ‘Gamma’ (An early version of EA’s ‘Alchemy’ scenario); ‘Green World’ [42] and ‘Technogarden’ (where Global markets in ecological property combine green technology, eco-efficiency, openness and competition [54]) which the Environment Agency suggest has similarities to their ‘Alchemy’ scenario (where a new regulatory environment spurs innovation in new technologies and new standards of producer responsibility [51]). Defra also noted similarities between ‘Alchemy’ and their own ‘Strong government’ scenario [43] (the later built upon the former). Both ‘Alchemy’ and ‘Technogarden’ have been linked to Natural England’s ‘SUCCEED through SCIENCE’ scenario [31] (where the global economy continues to be driven by innovation and everyone relies on business to keep the country growing), as shown in Figure 6. The ‘Green Policy’, (where ecologists influence central policy) and ‘Technocratic’, scenarios (where public engineers and technocrats influence policy) as proposed by Makropoulos *et al* [30] are very much policy related and therefore not dissimilar to PR. In ‘Policy reform’ (a scenario in which negative impacts of market mechanisms are tempered by the inclusion of mitigation programmes) it is argued that the socio-economic and political considerations may make it expedient for governments to take actions that favour citizens, rather than wait for the operation of the market to correct these ills [25], as this is drawn directly on the work of GSG the direct comparison with PR is unavoidable.

Several additions have been made to this list based on the adoption of similar descriptors and core values to PR, these are:

- ‘Leading the way’ – UK Government takes a hands on approach to ensure the transition to a Low carbon economy, investment in environmental research and technology is high [55];
- ‘Prosperous stewardship’ – a global player in economic terms with high regulation, innovation and a dry climate [56];
- *Urban Colonies* – good environmental practice is at the heart of the UK’s economic and social policies; new urban planning policies. Consumption has fallen. Resource use is now a fundamental part of the tax system and disposable items are less popular [47];

Figure 6. Archetypes by theme clusters **Bold** text shows scenarios included in this study, modified from [31]

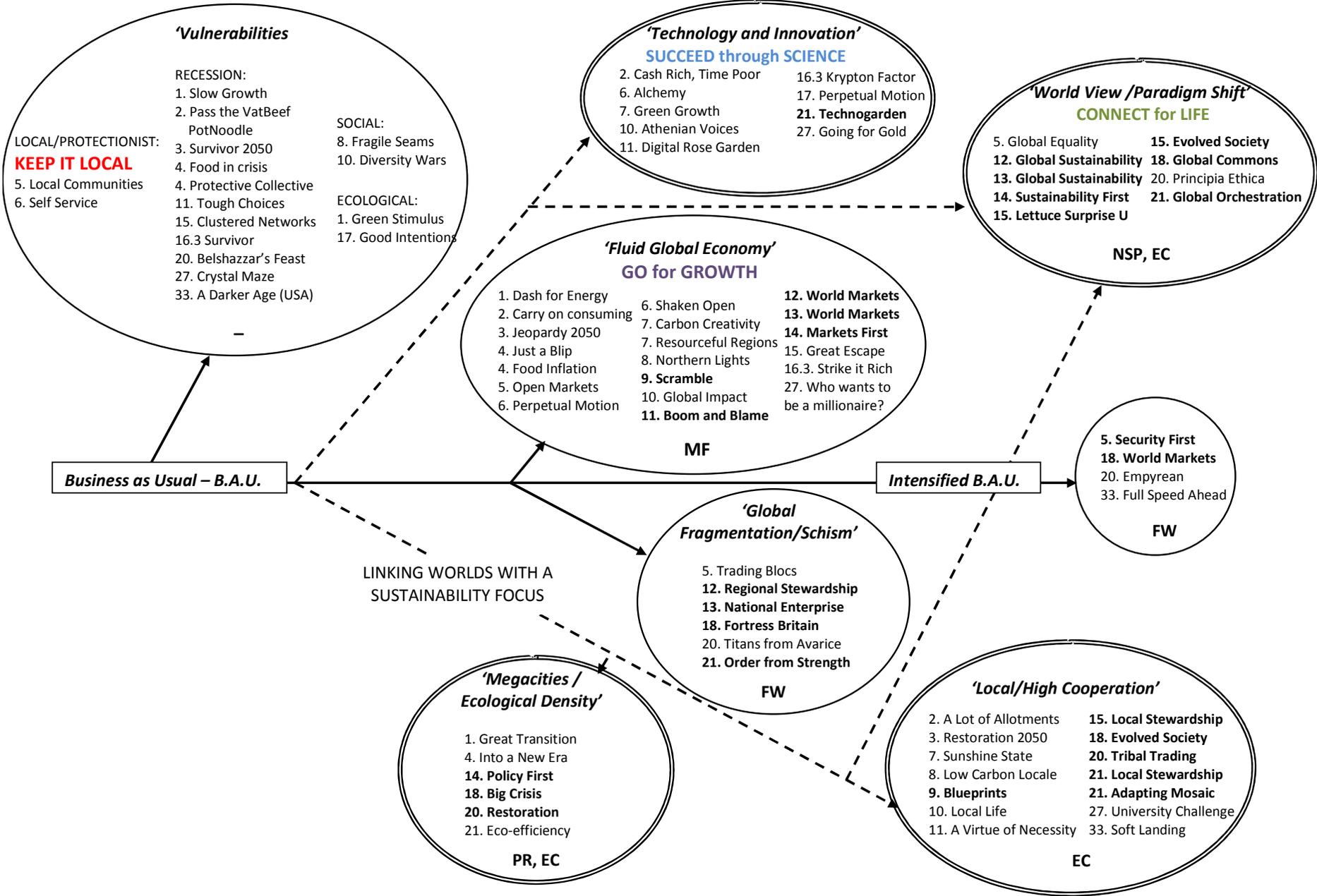


Table 2. GSG Archetypal social visions 1997 – 2011 (**Bold** - as described within the literature, *Italics* – additions from this research)

CONVENTIONAL		GREAT TRANSITIONS		BARBARISATION	
(MF) ¹	(PR) ¹	(NSP) ¹	(EC) ¹	(FW) ¹	(B) ¹
FROG ^{1c}	GEOpolity ^{1c}	Jazz ^{1c}	Sustainability First ^{1a}	Security First ^{1a}	A2 ^{1b}
Business as Usual ^{1d, 17}	Technology, Economics & the private sector ^{1d}	Values and Lifestyles ^{1d}	B2 ^{1b}	Fortress Europe ²⁵	<i>Diamonds</i> ¹⁶
Reference ^{1e}	Policy variants ^{1e}	Sustainability First ^{1a}	Local stewardship ^{7, 17, 18, 20}	Fortress World ^{2, 4, 42}	<i>Decline to disaster</i> ⁴¹
A1 ^{1b}	B1 ^{1b}	Restoration ⁵	Delta ¹⁵	A2 ^{1b}	
Markets First ^{1a}	Policy First ^{1a}	Sustainable Behavior ³²	Transformed – World ⁴²	National Enterprise ^{13, 20, 30, 33, 37,}	
Economy first ²⁵	Global sustainability ^{7, 13}	Global sustainability ^{7, 13}	Adapting Mosaic ¹¹	Regional-Stewardship ⁴⁰	
Global Orchestration ¹¹	Technogarden ¹¹	Global responsibility ^{20,}	Survivor ⁵	Order from Strength ¹¹	
Big is beautiful ⁴⁵	Knowledge is King ⁴⁵	B1 ^{1b}	Local resilience ³²	Scramble ^{11, 46}	
Global Economy ^{43, 47}	Big Crisis ⁴⁴	Green World ²⁸	Tribal Trading ¹⁷	Clustered Networks ⁴⁴	
Great Escape ⁴⁴	Strong Europe ⁴⁷	Living on the No.8 wire ³	Independent Aotearoa ³	Transatlantic Market ⁴⁷	
World Markets ^{7, 13, 17, 18, 20, 29 30, 33, 34, 35, 36 , 37}	Global Co-operation ⁴³	Civic renewal ⁸	Eco-communalism ²	Continental Markets ^{11, 43}	
Market World ^{28, 42}	Policy Rules ^{25, 26}	CONNECT for LIFE ⁶	Blueprints ⁴⁶	Fortress Britain ²⁹	
Beta ¹⁵	Alchemy ⁵	Global Orchestration ¹¹	Lettuce Surprise U ⁴⁴	Provincial Enterprise ^{7, 17, 18, 34, 35, 36,}	
Jeopardy ⁵	Global commons ²⁹	Global Commons ²⁹	Evolved Society ⁴⁴	Medium/Low-emissions ³¹	
Blinkered Evolution ⁸	Gamma ¹⁵	Great Transitions ⁴	Regional Communities ⁴³	Alpha ¹⁵	
New Frontiers ³	Green World ²⁸	Sustainable world ²	Sustainability ^{25, 26}	Fortress Europe ^{25, 26, 28}	
Market Forces ⁴	Strong government ³	<i>Hearts</i> ¹⁶	Eventually ^{25, 26}	Technogarden ¹¹	
Business as usual ²	Fruits for a few ³	<i>The triple whammy</i> ²¹	<i>Building lifeboats</i> ²³	Lords of Misrule ²⁷	
Free Markets ²	SUCCEED through ⁶	<i>Factor Four</i> ²²	<i>Medium/Low emissions</i> ³¹	<i>Rivers</i> ²⁶	
<i>Riding the tiger</i> ⁹	SCIENCE ⁶			<i>Turbulent Neighbourhoods</i> ¹⁰	
<i>Triumphant markets</i> ¹⁰	GREEN policy ²			<i>Boom and Blame</i> ¹⁴	
<i>World Markets</i> ¹³	Technocratic ²			<i>Last man standing</i> ²³	
<i>High Growth (F-0)</i> ²²	Policy reform ⁴			<i>Brown Tech</i> ¹²	
<i>GO for GROWTH</i> ⁶	<i>Leading the way</i> ³⁹			KEEP it LOCAL ⁶	
<i>Growing on</i> ²³	<i>Prosperous-Stewardship</i> ¹⁹				
<i>Perpetual motion</i> ¹⁷	<i>Urban Colonies</i> ¹⁷				
<i>Carry on consuming</i> ²⁴	<i>Low emissions</i> ³¹				
<i>Economy First</i> ^{25, 26}	<i>Innovation</i> ³²				
<i>Bazaar</i> ²⁷	<i>Business as usual (F-1)</i> ²²				
<i>High emissions</i> ³¹	<i>Powerdown</i> ²³				
<i>Market Forces</i> ³²					
<i>Uncontrolled demand</i> ³⁸					

References: ¹Raskin, 2005 [8] ^{1a}UNEP, 2002 [17,18], ^{1b}IPCC, 2000 [16], ^{1c}WBCSD, 1997 [12], ^{1d}Gallop and Rijsberman, 1999 [19] ^{1e}OECD, 2001, 2008 [14,15], ²Makropoulos *et al*, 2009 [30], ³Taylor *et al* 2007 [28], ⁴Ochala *et al*, 2006 [25], ⁵EA, 2006 [51], ⁶NESC, 2009 [31], ⁷Pridmore, 2003 [22], ⁸Defra, 2007 [43], ⁹Outsights, 2008 [44], ¹⁰Bertrand *et al* 1999 [45], ¹¹MEA, 2005 [54], ¹²Holmgren, 2009 [70], ¹³UKCES 2010 [83], ¹⁴HSE, 2007 [69], ¹⁵EA, 2001 [27], ¹⁶SA, 2007 [61], ¹⁷PIU, 2002 [81], ¹⁸IAG, 2002 [79], ¹⁹UKWIR, 2010 [56], ²⁰OST, 2002 [41], ²¹CA, 2003 [62], ²²SEEDA, 2003 [46], ²³Heinberg, 2003 [57], ²⁴Steedman and Schultz, 2009 [48], ²⁵Kämäri *et al*, 2008 [34], ²⁶Duel *et al*, 2010 [35], ²⁷Ratcliffe, 2000 [49], ²⁸PMSU, 2004 [42], ²⁹Pinnegar *et al*, 2006 [23], ³⁰OST, 2004 [59,60], ³¹Hulme *et al*, 2004 [50], ³²EA, 2006 [51], ³³Sami, 2007 [39], ³⁴Foresight, 1999 [40], ³⁵Watson *et al*, 2004 [67], ³⁶ERAG, 2001 [58], ³⁷Berkout and Hertin, 2002 [68], ³⁸EA, 2010 [52], ³⁹Go-Science, 2010 [55], ⁴⁰HFP (2007), ⁴¹Hala and Marien, 2011 [72], ⁴²Hammond, 1998 [11], ⁴³EURuralis, 2004 [78], ⁴⁴EEA, 2007 [77], ⁴⁵Rotmans *et al*, 2000 [112], ⁴⁶Shell, 2008 [82], ⁴⁷Mooij and Tang, 2003 [80],

- 'Low emissions' [50];
- *Innovation* – Previously *Alchemy*, in this world people work in regulation and compliance, environmental concerns are the problem of manufacturers and service providers - supply side regulation (for water) is an accepted integral part of the economy [52];
- '*Business as usual – B-A-U*' describes strict controls for land-use planning, a balance between growing volumes and increasing recycling rates and adoption of techno-fixes for carbon capture [46] – as such it describes perfectly a policy centric B-A-U for the UK; and
- '*Powerdown*' – refers to the path of self-limitation, cooperation and sharing; an orderly equitable transition to a low-carbon economy, this mirrors the steps being taken within a PR world [57].

2.2. Great Transitions

The first variant within the great transitions archetype is '*New Sustainability Paradigm - NSP*'.

NSP sees new humane globalization (rather than localism) change the character of urban industrial society [21]. A values-led change catalyzed by the push of deepening crises and the pull of desire for a just, sustainable, and planetary civilization. This new paradigm is rooted in human solidarity, universal access to education and health care services, ecological resilience, reduced consumerism (technology is as good as it gets but matched also by a step-change in behavior [6]), improved well-being, e.g. creativity, leisure, relationships, and community engagement) and quality of life [33]. NSP is a more cosmopolitan vision than EC, because it is a world that would transcend and transform urban and industrial civilization, and maintain global linkages and solidarity, rather than retreat into localism [10]. The improved social cohesion reduces conflict; crises may still linger, but the world is able to confront them with enhanced institutions for reconciliation and cooperation [33].

Raskin [21] first suggested that this scenario is broadly similar to:

- *Jazz* – where markets are harnessed for finding solutions to sustainable development [12];
- *Values and Lifestyle* – Sustainable development, with an emphasis on research and development in the poorest countries [19,20], and
- *Sustainability First* – a world in which a new development paradigm emerges in response to the challenge of sustainability, supported by new, more equitable values and institutions [17,18].

According to the Environment Agency this scenario is also very similar to their '*Restoration*' scenario (a world where societal values and behaviour are oriented more towards sustainable development goals as a result of greater awareness and perception of environmental risk [51] – subsequently renamed to '*Sustainable Behaviour*' [52]) and Foresights '*Global Sustainability*' scenario, e.g. like Netherlands [39] also known as '*Global responsibility*', [41,58] a world with: strong index of sustainable economic welfare and climate management, conservationist values (biodiversity is stable), global governance, renewable energy, less resource intensive manufacturing, equity, and improved air and water quality [59,60]. Previously Pridmore [22] suggests a closer alignment between '*Global sustainability*' and '*BI*' [16] based upon strong global-environmental focus, this relationship being confirmed by de Vries [24] in Figure 2. Hence the subtle similarities with '*Green World*' (aligned previously with PR) cannot be ignored. Figure 7 shows the close alignment of a number of the scenarios aligned under NSP according to key drivers [26].

Figure 7. Qualitative patterns of change in NSP according to key drivers, modified from [26]

Scenario	Population	Solidarity	Technology	Economy	Environment	Regulation	Globalization
NSP (GSG)							
B1							
Sustainability First							

Taylor *et al* [28] suggests that some elements (i.e. restorative stages) of their ‘*Living on the No.8 Wire*’ scenario (where New Zealand reacted too late to sustainability challenges and got left behind globally, but social cohesion permitted an indigenous and inventive subsistence in the economy, as seen in other Pacific Islands) resonate well with ‘*Restoration*’ (mentioned earlier) which in turn is assumed by Defra [43]) to resonate well with their ‘*Civic renewal*’ scenario (a world where British citizens and consumers, rather than British politicians, begin to change their behaviour – this being a strong characteristic that resonates well within NSP).

As can be seen in Figure 6, Natural England align their ‘*CONNECT for LIFE*’ scenario (where people now connect through vast global networks [31]) with ‘*Global Orchestration*’ (a world of sustainable development, economic growth, fair trade, global public health, global education, global NGO and multilateral organizations [54]), ‘*Global Sustainability*’ (mentioned previously), ‘*Sustainability First*’ (mentioned previously) and ‘*Global commons*’ (a world where people aspire to high levels of welfare and a sound environment - driven through International co-operation towards global sustainability [23]). It is interesting to note that ‘*Sustainability First*’, whilst being environmentally focused, provides a balance between global and regional (i.e. spanning somewhere between NSP and EC), although its position is best described by Figure 1b rather than 2. ‘*Great Transitions*’ is a world in which the three pillars of sustainable development are strengthened and behavioural patterns that characterize modern societies, such as consumerism, give way. As such a new level of satisfaction that is not materialistic is defined [25]. It is worth noting that de Vries [24] locates ‘*Great transitions*’, a combination of EC and NSP as defined by Hammond (1997), in the lower right hand quadrant in Figure 2, however, when NSP is disassociated from EC within this archetype, the former would move vertically upwards (into the upper quadrant) whereas the later would move marginally downwards. Macropoulos *et al* [30] align their ‘*Sustainable world*’ (a world where integrated solutions are the aim) directly with NSP, as it draws narratives from this research.

Several addition have been made to this list based on the adoption of similar descriptors and core values to NSP, these are:

- ‘*Hearts*’ – Environment wins, Society Wins - This is a world in which demography, politics, economics, and sustainability gel. It is the future that the Brundtland Commission pointed us towards [61];
- ‘*Triple Whammy*’ – based upon a combined approach to environmental, social and economic sustainability [62]; and
- ‘*Factor Four*’ – a more sustainable, low-impact food system that improves significantly demand-side management in addition to re-use, recycling and composting [46].

The second scenario within the great transition world is ‘*Eco-communalism - EC*’.

Eco-communalism envisions a patchwork of semi-isolated and self-reliant communities; quite sustainable with high equity, low economic growth, low populations [8] with a bio-regional focus, a highly localist vision and face-to-face democracy, [21]. EC contrasts with NSP by:

embracing the principles of strong decentralization; small-scale technology; and economic autarky [10]. Although it has been suggested by Gallopin et al [8] that an EC world could emerge out of an NSP world, if powerful consensus arose for localism, diversity and autonomy. Although just as likely it could emerge from the recovery of Breakdown [8]. A major threat to sustainability could come from the possibility that some of the more or less isolated communities develop into aggressive, expansionist forces which attempt to dominate neighbouring communities [8].

Raskin [21] first suggested that this scenario is broadly similar to:

- ‘B2’ [16], which de Vries [24], in Figure 1, aligns closely with
- ‘Local stewardship’ – a world with conservative values, regional/national governance, locally based financial and other services, and small scale intensive agriculture and manufacturing [41,59,60] - like Denmark, Sami [39] - this relationship being confirmed by Pridmore [22], EA [51] and Pinnegar *et al* [23], the last of these authors include also
- ‘Delta’ – an early version of EA’s ‘Survivor’ scenario, and
- ‘Adaptive Mosaic’ – a world of local regional co-management; common property institutions; integration of local rules regulate trade; local non-market rights; local communities; local equity and cooperatives [54].

The Environment Agency suggested similarities between their ‘Survivor’ scenario (a scenario in which the consumers become more frugal and self-reliant with resurgence in traditional regional and local cultures and values [51] - subsequently renamed to ‘Local Resilience’ [52]) and Foresight’s ‘Tribal Trading’ scenario (a world shrunk to their own community, a global economic system that is severely damaged with infrastructure falling into disrepair, local food production and services and local transport - typically by bike and horse. There are local conflicts over resources: lawlessness and mistrust are high. The state does what it can – but its power has been eroded [47]). Landcare Associates suggest that some elements of their ‘Independent Aotearoa’ scenario (also known as the ‘Shire’) were broadly similar to ‘Tribal Trading’, the link to EC is easily recognised given the references to a world that has international geopolitical instability, strong social cohesion and a voluntary disconnect from globalization. In other words, as Taylor describes it: equitable, educated, environmental – friendly and dull. Macropoulos *et al* [30] align their ‘Eco-communalism’ (green visions of bioregionalism, localism, face to face democracy, small technology and economic autarky) directly with EC. From Figure 1a, b other scenarios include: *Blueprints*, *Lettuce surprise U*, *Evolved Society*, *Regional Communities and Sustainability eventually* (a world where water demand has structurally decreased, derived from ‘Sustainability First’ [34,35]).

During this research the following additions have been made to this list based on the adoption of similar descriptors and core values to EC, these are:

- ‘Building lifeboats’ – the path of community, solidarity and preservation [57] and
- ‘Medium/Low emissions’ [50].

2.3.Barbarisation

The first scenario within the barbarisation archetype is ‘Fortress World - FW’

Authoritarian rule, elites in “fortresses,” poverty & repression outside; an authoritarian response to the threat of breakdown; from protected enclaves, elites control an impoverished

majority and manage critical natural resources [9,10,33] Strategic mineral reserves, freshwater and important biological resources are put under military control, as are favoured resort areas, including nature and hunting preserves, from which the poor are excluded [8]. This is a world in which wealth, resources and conventional governance systems are eroding and alliances are formed to protect the privileges of rich and powerful elites in their bubbles of privilege. Outside the fortress, the majority is mired in poverty, denied access to scarce resources and restricted in mobility, expression and basic rights [8]. Authorities employ geo-engineering techniques to stabilize the global climate, while dispatching militia to multiple hotspots in an attempt to quell social conflict and mass migration. But the results are mixed: emergency measures and spotty infrastructure investment cannot keep pace with habitat loss and climate change; inadequate food and water to desperate billions [33]. Technology is maintained in the fortresses, even with some continued innovation, but deteriorates elsewhere. Local pollution within the fortress is reduced through increased efficiency and recycling. Pollution is also exported outside the enclaves, contributing to the extreme environmental deterioration induced by the unsustainable practices of the desperately poor and by the extraction of resources for the wealthy [8]. In this kind of future, sustainable development is not in the cards, a half-remembered dream of a more hopeful time [33]. Global equity is very low, though it could be high within the fortress, and outside. For those unfortunate enough to be born poor, life is Hobbesian: nasty, brutish, and short. A general uprising of the excluded population is plausible and the collapse of FW could lead to Breakdown [8,23,53).

Raskin [21] suggested that this scenario was broadly similar to:

- GEO's 'Security First' scenario (a world of great disparities, where inequality and conflict prevail, brought about by socio-economic and environmental stresses [17,18];
- GEO-4, 2008, this was developed by Duel *et al* [35] into 'Fortress Europe' as shown in Figure 1b; a world in which Europe closes its borders and concentrates on a series of security issues, a central goal of which is self-sufficiency, co-operations are difficult, alliances change and water conflicts intensify) and
- AEO's 'Fortress World' scenario, the later being developed from the former [25].

The last of these scenarios has been linked directly to 'A2' (A high regional-economic focus [16] by de Vries [24], in addition to 'Barbarisation' which includes FW and B [11] – See Figure 2. [It can be seen that 'Security First' is the least localized of the scenarios considered under FW, thus far - economics being broadly similar in each case. The reference to 'clash of civilizations' [64] in Figure 2, is understandable given the context of a world in which global affairs and interactions are between "civilizations" rather than nation-states. Figure 8 [26] shows the close alignment of a number of scenarios under NSP according to key drivers, these relationships being confirmed by Zurek [37] and Westhoek *et al* [38].

'Fortress World', as derived by Makropoulos *et al* [30], is based upon narratives drawn from FW and therefore shows considerable similarities: e.g. environmental conditions that deteriorate rapidly; pollution; climate change; and ecosystems degradation that interact and amplify the crisis. The links between FW and 'National Enterprise' as identified by Makropoulos *et al* [30] can be seen in Figure 4; a world committed to building capabilities and resources to secure a high degree of national self-reliance and security. Political and cultural institutions are strengthened to buttress national autonomy in a more fragmented world [47] - like Switzerland [39], although increasingly like North Korea, Fortress India and others.

Figure 8. Qualitative patterns of change in FW according to key drivers
(modified from Gallopin et al., 1997 and Busch, 2006)

Scenario	Population	Solidarity	Technology	Economy	Environment	Regulation	Globalization
FW (GSG)							
A2							
Security First							
Continental markets							

More recently NESG [31] have aligned ‘*National Enterprise*’ with ‘*Regional Stewardship*’ [65] and ‘*Order from Strength*’ [54]. This was presumably related to the fact that all these scenarios include the requirements for ‘high regulation’ (i.e. national level policies), security and protectionism within a climate of fear - all of which are consistent with the descriptors of FW. Pinnegar *et al* [22] recognised that ‘*Order from Strength*’ correlated well with their ‘*Fortress Britain*’ scenario (This scenario assumes that people aspire to personal independence and material wealth within a nationally-rooted cultural identity that gets in the way of global sustainability) in addition to UKCIP’s ‘*Fortress Britain*’ [66], ‘*Provincial Enterprise*’ (a precursor to ‘*National Enterprise*’ [67]); ‘*Fortress Europe*’ [42] ‘A2’ and the Environment Agencies ‘*Alpha*’ scenario [27] - subsequently changed to ‘*Survivor*’ (EA, 2006) and the ‘*Medium-High emissions*’ scenario [68]. Whilst Landcare Associate’s ‘*Fruits for a few*’ (benefits of global market access, communications, health protection and use of natural resources are aspects reserved to an elite, which also values sustainability, [28]) has been linked closely to ‘*Technogarden*’ (aligned previously with PR) reference to a dissenting and landless majority of population resonates also with FW (Section 2.3). Busch [26] and Kok *et al* [32] confirm a number of these relationships (Figure 1a,b) with the addition of: ‘*Scramble, Transatlantic Market and Continental Markets*’

Several additions have been made to this list based on the adoption of similar descriptors and core values to FW, these are:

- ‘*Lords of Misrule*’ – a fortress world with socio-political backlashes and regressive development in institutions [49];
- WBCSD’s ‘*Rivers*’ scenario – a world of ‘Haves and Have-nots’ [12];
- ‘*Turbulent neighbourhoods*’ – a world of physical security, muscular military action and the formation of a fortress Europe [45];
- ‘*Boom and Blame*’ – a world of privileged enclaves and ghettoised communities [69];
- ‘*Last man standing*’ – the way of war and competition operate in this world – globally disconnected, a survivalist approach [57];
- ‘*Brown Tech*’ – a world in which the security of the “haves” is a constant issue with gated communities, and apartheid style townships and barriers for the “have-nots”, [70];
- ‘*Keep it local*’ – a society that revolves around nations feeding and providing for themselves, [31,71];

The second scenario within the barbarisation worlds is ‘*Breakdown - B*’. This archetype is the least well-adopted within the literature, perhaps because it is the world we would least like to consider possible. In addition it is likely to be a difficult scenario in which to test things (e.g. sustainability solutions) because it might be considered ‘too-far-gone’.

In this variant, the vicious cycle of chaos, conflict and desperation spiral out of control. The security apparatus within remaining privileged areas cannot contain the tide of violence from disaffected individuals, terrorist organizations, ethno-religious groups, economic factions, and organized crime. Collapse of civil order becomes widespread, as populations become increasingly desperate and governments weaken. Refugees fleeing from chaotic zones destabilize neighbouring areas, inadvertently contributing to widening waves of disorder. To stem migration, increasing resources are devoted to police powers, border security, and control of the activities of citizens. The global economic, finance and governance systems founder, though the media lingers to spread fresh news of upheaval. The retreat of globalization is particularly devastating for industrial economies highly dependent on trade and imported natural resources. The results are: rising unemployment, economic depression, political instability, and outbreaks of civil disorder, even in rich countries. This self-reinforcing chain of events eventually leads to a general disintegration of social, cultural, and political institutions, deindustrialization (to varying degrees in different regions), and in many regions a return to semi-tribal or feudal societal structures. With the collapse of markets and investment generally, technological progress halts -- and the level of technological capability regresses. Population eventually begins to decrease as mortality rates surge with economic collapse and environmental degradation. Many couples, deeply pessimistic about the future, choose not to bring children into the world. In a bitter irony, equity increases but only because everybody gets poorer. Breakdown conditions could persist for many decades before social evolution to higher levels of civilization again becomes possible [8].

Raskin [21] first suggested that this scenario was broadly similar to:

- IPCC's 'A2' scenario [16] – a fragmented unsustainable world. It is interesting to note that Raskin does not align 'A2' with FW and yet this shows that incredible similarities do exist.

'Diamonds' [61] and 'Decline to disaster' [72] have been added to the list due to their reference to devastation of ecosystems and a triple bottom line in tatters, this includes: global economic depression, crippling energy shortages, local and regional wars, rampant terrorism, crime, corruption and more.

3. Discussion

This research has shown that, based upon the descriptions given within their scenario narratives, seemingly disparate visions of the future can be aligned under the three world end-states and six scenario variants first proposed by GSG. In some cases the similarities are not surprising given that the work derives directly from, or links to, GSG. For example, the AEO – African Environmental Outlook scenarios [25] were developed using the rich narratives from 4 of the GSG scenarios (PR, MF, NSP, FW) combined with IPCC emissions data [16] and in the case of Global Environment Outlook [17,18] the GSG actors were directly involved [73]. In other cases the adoption of a similar methodological approach or adoption of identical 'key drivers', leads to unavoidable similarities. For example, Makropoulos and colleagues [30] developed 7 water-based scenarios based directly upon GSG's work [9,10] and that of Schilling [74]. What is most reassuring is that, whatever the methodological framework adopted a significant number of scenario variants developed by a range of authors all align to the 3 world states and 6 visions derived by GSG; in this paper >150 scenarios have been aligned with the GSG scenarios based solely on information provided in their narratives (Table 3). Based on these findings, this discussion section considers whether the archetypal set of scenarios first proposed by GSG might be deemed appropriate for adoption by research institutions wishing to test against

existing scenarios, rather than to derive, refine and test for internal consistency yet another scenario set.

3.1. Archetypal visions: Are the 3 world end-states proposed by GSG appropriate?

In 1998 Hammond based the title of his book *'Which World? Scenarios for the 21st Century'* [11] on the results of the 2050 project (a joint venture between the Brookings Institution, the Sante Fe Institute and the World Resources Institute – of which Hammond was director) and in line with GSG investigated 3 possible world end-states (Market, Transformed and Fortress) within 7 continents. The three worlds suggested by Hammond map directly onto the four GSG archetypes derived by Gallopin *et al* [8] and adopted by Raskin [21] (not surprising given that Hammond was part of the GSG team).

Van Asselt *et al* [4] subsequently suggested four scenario archetypes based on their key combining elements: *'Think Green'* - Environmental protection; *'Money maker'* - high economic growth; *'Wait and See'* - limited policy action, and *'Doom Monger'* – a pessimistic outlook. The link with GSG archetypes is self-evident and is not dissimilar to the 4 archetypal classifications (based upon 10 scenario sets - 40 scenarios) presented by Wilson [75]; *'Market dominance'*; *'Global Institutional Governance'*; *'Fortress against the storms'*, and *'People power'*.

Figure 9 shows a family tree of scenario archetypes as presented by Tibbs [76] in which it is particularly easy to identify the GSG archetypes. Moreover, it illustrates how archetypes are related and identifies phases likely required to pass through before reaching the different worlds – something previously well recognised by GSG [8].

Morita *et al* [36] grouped 124 scenarios from 48 sources (derived from 1980-99) 43 of which predated the work of GSG, according to demographic, socio-economic, technological and environmental dimensions (Table 3). It was recognised by Morita and colleagues that three archetypes matched closely those first proposed by GSG.

In 2009, Natural England considered 35 different scenarios from the literature where land-use had been considered, and suggested the emergence of five archetypal visions (Figure 6 and Table 4, [32]). The similarity between these archetypes and those suggested by Hammond [11] and GSG are self-evident (Table 1). Excepting, the use of *'business as usual'* does not help, and this is something that the GSG have previously adopted and because of the confusing connotations replaced with *'Conventional worlds'*.

Whilst Tibbs [76], Morita [36] and NESG [32] present an archetypal set related to *'Technology'* alone, it could be argued, that it is perhaps not required, as the technology driver cannot be divorced from the other archetypes, e.g. GSG assigns PR and NSP the best technologies (Figures 5 and 7) and technologies are already heavily embedded within *'Paradigm shifts'*. We already live in a technological age - what is distinctively important is what pulls or pushes the technological adoption to occur, and how this might be intertwined with user-behavior (Section 3.3). This is remiss in other scenario sets and something on which the GSG scenario variants provide significant clarity. Notwithstanding this observation, similar adoption has occurred within the water engineering field (e.g. Macropoulos *et al* [30]) which is not surprising given that technology is considered to be a key driver.

Kok *et al* [32] highlighted the practical implications for being able to link scenarios and use additional information from other studies provided that scenarios could be categorized in a similar structure. The difficulty here is ensuring that internal consistency is assured whilst characteristics are being cherry picked. Table 5 was created for the CLIMSAVE scenarios project based on the similarities found between scenarios (Figure 1a). Once again the match to GSG archetypes is very strong.

Figure 9. Scenario archetype family tree
(Modified from Tibbs [76], to show location of GSG scenarios)

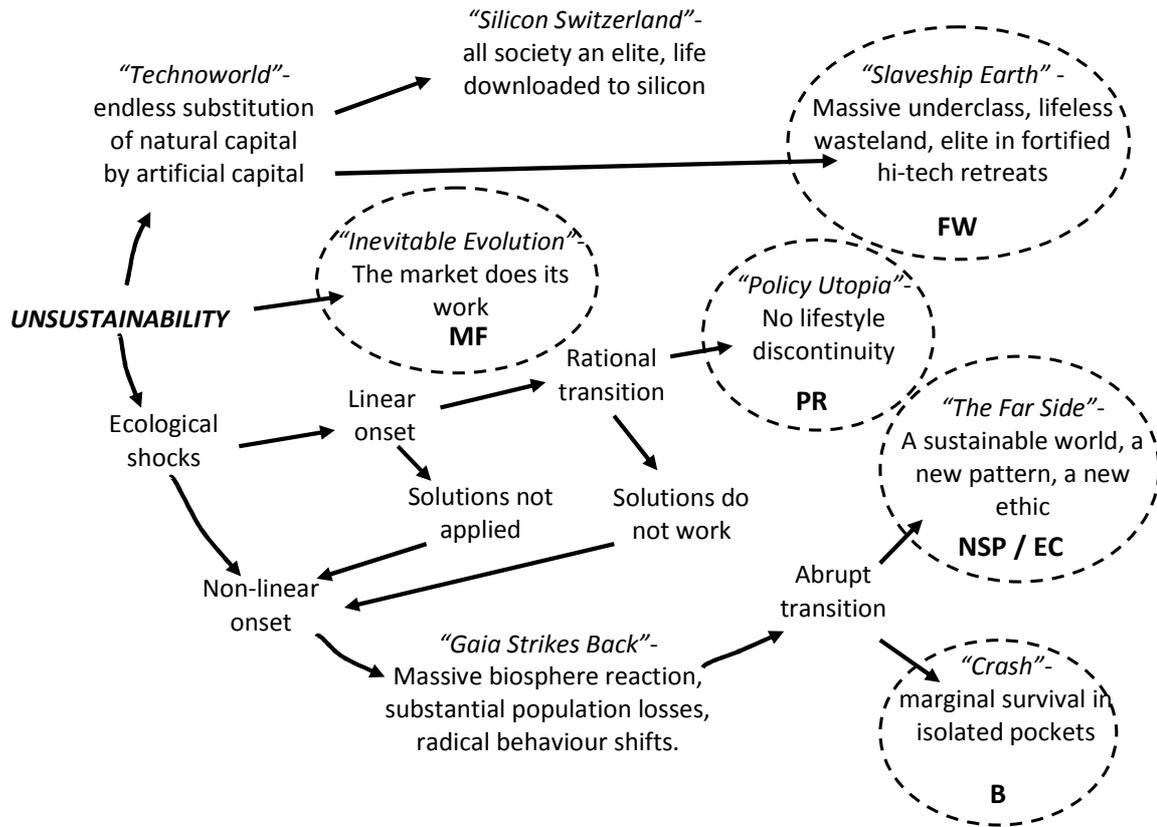


Table 3. Scenario archetypes, adapted from [36]

Archetypal visions	Scenario Sub-Group	No Scenarios	Link to GSG
'Current Trends'	<i>Conventional:</i> no significant change and/or continuation of current trends	12	MF, PR
	<i>High Growth:</i> government facilitates business, leading to prosperity	14	
	<i>Asia Shift:</i> economic power shifts from the West to Asia	5	
	<i>Economy Paramount:</i> emphasis on economic values deterioration in environmental and social conditions	9	
'Sustainable Development'	<i>Our common Future:</i> increased economic activity is made consistent with improved equity and environmental quality	21	NSP, EC
	<i>Low consumption:</i> conscious shift from consumerism	16	
'Pessimistic'	<i>Breakdown:</i> Collapse of Human Society	5	FW, B
	<i>Fractured World:</i> Deterioration into antagonistic regional blocs	9	
	<i>Chaos:</i> Instability and Disorder	4	
	<i>Conservative:</i> World economic crash is succeeded by risk-averse regime	2	
'High-Tech Optimist'	<i>Cybertopia:</i> information and communication technology facilitate individualistic, diverse and innovative world	16	-
	<i>Technotopia:</i> technology solves most of humanity's problems	5	
References [84 – 126 respectively]: Barney, 1993; Bossel, 1998; Coates and Jarratt, 1990; Coates, 1991, 1997; Cornish, 1996; Costanza, 1999; CPB, 1992; Duchin <i>et al.</i> , 1994; GBN, 1996; Glenn and Gordon, 1997, 1998; Henderson, 1997; Hughes, 1997; IDEA Team, 1996; Kahane, 1992; Kinsman, 1990; Linden, 1998; Makridakis, 1995; McRae, 1994; Meadows <i>et al.</i> , 1992; Mercer, 1998; Millennium Project, 1998; Nakicenovic <i>et al.</i> , 1998; Olson, 1994; Price, 1995; Ramphal, 1992; Repetto, 1985; Rotmans and de Vries, 1997; Schindler and Lapid, 1989; Schwartz, 1991, 1995; Schwartz and Leyden, 1997; Science Advisory Board, 1995; Shinn, 1982; Stokke <i>et al.</i> , 1991; Sunter, 1992; Svedin and Aniansson, 1987; Toffler, 1980; van den Bergh, 1996; Wallerstein, 1989; 1998; Wilkinson, 1995; World Bank, 1995; WRI, 1991.			
The following are included in Table 2: GSG [8]; IPCC [16] OECD [13]; WBCSD [12];			

Table 4. Archetypal social visions for the future, adapted from [31]

Archetypal visions	Details (refer also to Figure 4)	Link to GSG
'Business as usual'	A world that prioritises government and the economy.	MF
'Sustainability'	A world that prioritises the environment - through efficiencies of scale in urban settings, or through decentralisation and focus on communities and locales.	PR, NSP
'Paradigm shifts'	A world where current assumptions about future governance or the economy are overturned. They are often connected to worldview and value shifts that are <i>enabled by new technologies</i> .	EC
'Collapse (vulnerability)'	A world with economic difficulties, social schisms and / or environmental degradation.	FW
'Technological Age'	A 'high tech' world transformed primarily by technological fixes.	-

Table 5. Archetypal social visions for the future, adapted from [32]

Archetypal visions	Details (refer also to Figure 1a)	Link to GSG
'The Global Market'	Global developments steered by economic growth result in a total dominance of international markets with a low degree of regulation. Environmental problems are being dealt with when solutions are economically interesting	MF
'Global Sustainability'	A globalised world with an increasingly proactive attitude of policy-makers and the public at large towards environmental issues and a high level of regulation. Three main variations can be discerned. One where the global solution is technology change, one with strong governance structures and one with a broadly supported paradigm shift.	PR, NSP
'Regional Sustainability'	A regionalised world, where most – broadly supported initiatives improve the state of the environment and move toward sustainable solutions are bottom-up with a major role for NGOs and multi-level governance structures	EC
'Continental Barriers'	A regionalized world based on economic development. The market mechanism fails, leading to a growing gap between rich and poor. In turn, this results in increasing problems with crime, violence and terrorism, which eventuates in strong trade and other barriers	FW

Therefore it appears that the three world end-states proposed by GSG are sufficiently diverse, distinct, clearly defined, well-grounded, defensible, and wholly appropriate including key world drivers (social, technological, economic, environmental, political, organisational, and security) that are as relevant today as they were some 16 years ago. Moreover, If data from Morita [36] are included it might be suggested that there is >30 years worth of evidence to back up GSGs scenario archetypal visions. As such user buy-in is achieved easily, as evidenced by critical acclamation of Hammonds' book [127] and the significant global citations of GSG's work within the scenarios literature.

3.2. Scenario variants: Are six variants appropriate?

In general practitioners recommend that two scenarios be considered the minimum (one is too easily mistaken for a forecast) and four scenarios appear to be the maximum number for easy audience engagement while still allowing for depth and rigor of analysis [128]. In many cases when tasked with getting an audience to imagine a different end-state to their place of reference, it is not inappropriate to assume that the audience are likely to draw from images of places that may not conform to their sense of normality and yet, albeit subconsciously, are related to something they have seen, or heard of, in other parts of the world. This may be the underlying reason why MF, PR, NSP and FW scenarios work so well and have been so well-adopted within the literature even when derived in seemingly different ways – credibility is gained because people can imagine living there. That said the use of a national tagging could be misleading, although this very much depends upon the scale being considered, for

example the UK, at national scale, might be assumed to align with the characteristics used to define PR and yet glimpses of each of the different world-end states may be evident nationally (the next county) or locally (i.e. the next street or the next house).

It is interesting to see that ‘*Breakdown - B*’ scenario is less-well adopted within the literature (only three of the scenarios assessed here align with Breakdown) and whilst a narrative was developed by GSG, detailed numerical analysis was not considered. This perhaps reinforces the notion that this marginalized world end-state variation is less useful analytically than FW, where the premise is to avoid the immediate threat of Breakdown. Therefore it is not surprising that authors align it closely with FW using two ‘axes of uncertainty’ (Figure 1). However, it could be argued that breakdown can occur at any point in time from any scenario, exemplified in the 1990’s by the LA riots (MF breakdown?) or in 2011 by the UK riots (PR Breakdown?) and the overriding goal in these cases is to restore democracy. Whilst ‘*Eco-communalism - EC*’ is well-adopted within the literature, it once again was not explored by GSG with detailed numerical analysis, perhaps because its distinction from NSP in terms of sustainability is not clear-cut: both consider heavily the role of the environment and both operate at global and local levels (Figure 1).

3.3. Scenario variants: Are six variants appropriate?

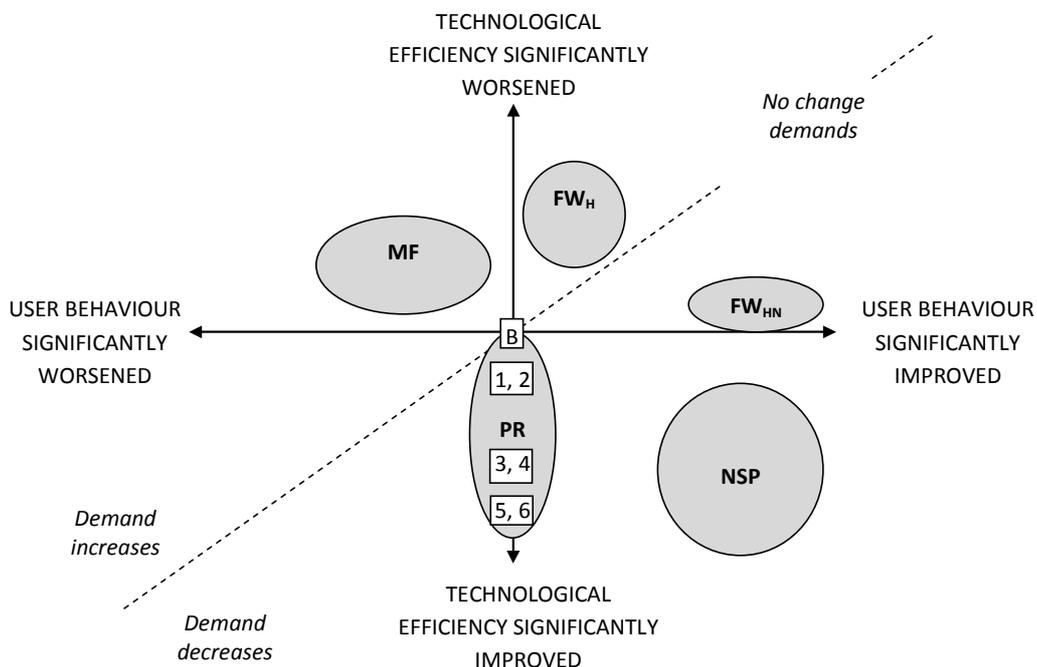
Many of the scenarios reported here (including OST) adopt an ‘axes of uncertainty’ approach (Figure 1 to 3) as distinct from the ‘key drivers’ approach used by GSG (Section 2). It is interesting to note that the UK-based Office of Science and Technology (OST), responsible for a significant portion of UK scenarios work in the last 15 years, adopts both ‘*Global sustainability*’ (aligned with NSP) and ‘*Local stewardship*’ (aligned with EC). Unfortunately, whilst elements of policy are embedded within all four scenarios, it is not considered as a main driving force in any single scenario, even though it could be argued that such a scenario would best represent the situation in the UK. Hence there are more synergies with GSG’s PR albeit representing the UK with significantly strengthened policies.

It is testament to the flexibility and applicability of the GSG scenarios that they can be mapped accordingly and yet still keep the necessary divergence that allows for meaningful research-based (sensitivity-type) analysis within a controlled system boundary (Figure 3). The placement of the scenarios (or the size of the containing bubble) within any of these grid like structures is not exact, and will be, to some extent, subject to judgment. Moreover it is important to appreciate certain caveats; scenarios may be located within the same quadrant and share an archetypal vision, but not be identical, that is, they will more than likely have subtle variations within characteristic sub-sets. Notwithstanding this shortfall, for research purposes the process of plotting GSG against any existing (or new) set of axes facilitates identifying similarities between scenario variants and can be used to identify potential research areas for further interrogation.

For example, in Figure 10 the four GSG scenarios (MF, FW, NSP and PR) are mapped against two key drivers (SOCIAL - user behavior and TECHNOLOGICAL - technological efficiency). The mapping process reveals a level of detail within the GSG scenarios that makes them rather unique amongst others found within the scenarios literature. Firstly, technological efficiency and behavior adoption in each scenario is diverse and yet can be traced back to a single driving force within the scenario (i.e. that which pushes or pulls a change to occur). For example, in PR and NSP it is evident that both adopt high levels of sustainable technological efficiency, however, in PR changes are pushed through policy impacting very little on changing user behavior (which, it could be argued, is not altered for the better or constrained from getting worse). In many respects this matches directly the approach being taken within the Code for Sustainable Homes in the UK, which might be considered as weak, medium and strong forms of PR, where B represents the baseline of where we are now, and 1 (least sustainable) to 6 (most sustainable) represents the various levels of the Code. This compatibility is extremely important when making scenarios directly relevant to current UK policy makers and

stakeholders. Conversely in NSP peoples' willing change in behavior (to more sustainable) is the pulling force which requires adoption of more higher efficiency technologies, whilst policy facilitates this action it is not required as a stimulus to effect change. Sustainability performance is based on voluntary reduced demand performance (e.g. 80 litres per person per day of water or zero heating requirements in homes). What is most interesting is the performance of NSP could match exactly that achieved in FW_{HN} (i.e. for those that have-not) but for completely different reasons. The push in FW_{HN} is lack of available resources (perhaps rationing) that demands a significant step change in behavior, likewise the push in FW_H is security of supply. In MF the pull is peoples' growing demand, which in this world must be met and the push is an expanding economy where more goods are made widely available.

Figure 10. Four GSG scenarios mapped onto technological efficiency and user behavior axes (B is baseline, 1-6 represent various Levels of Code for Sustainable Homes)



4. Conclusions

In summary the GSG scenarios are credible, internally consistent, thought provoking (i.e. within and outside ones comfort zone) and carry a pedigree that can be traced back over 20 years. In addition, having evaluated the various mapping exercises undertaken within the literature, this present research suggests that a significant number (> 150) of scenarios since 1997 can be mapped to the original archetypal visions derived by the GSG. [This increases to almost >280 if the timeframe is increased to 1980.] The greatest advantage of the GSG approach is that the world end-states can be mapped onto any set of axes (thereby facilitating detailed interrogation) with a high degree of divergence (a key requirement for meaningful futures sensitivity analysis); this is testament to the original conception of the GSG scenarios and their subsequent refinement over a 16 year period. Moreover the scenarios are highly dramatized, showing a deep understanding of the key fundamental drivers of change. The most relevant scenarios for UK-based research appear to be MF, PR, NSP and FW, although it should be recognized that the level of refinement within narratives will be directly related to the scale of adoption (i.e. national vs local). Therefore further work is required to quantify the relevant (sustainability) indicators within scenarios; this is the focus of future UF research publications.

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