Innovation Pathways to Adaption for Humanitarian and Development Goals: A Case Study of Aftershock Forecasting for Disaster Risk Management

Hope, M. J.; McCloskey, J.; Hunt, D.; Crowley, D.; NicBhloscaidh, M.

1. Introduction

Innovation is central to adaption, disaster risk management (DRM) and effective humanitarian and development practice (Betts & Bloom 2014, Bloom & Faulkner 2015). However, innovation theory sits outside the theoretical frameworks that are core to the adaption-development paradigm (Ramalingham, Scriven & Foley 2009). Product innovation models taken uncritically from business and management present innovation as linear and mechanistic rather than complex and emergent, and neutral and technical rather than a political project of social change (Mulgan et al 2007). Small teams often develop humanitarian and development innovations, and there is doubt over whether these projects are big enough to drive the large-scale deep change required to respond effectively to climate change and development challenges (Termeer et al 2017). Interesting work is being done that frames innovation as 'social innovation' and there is good scope for these approaches to integrate with the adaption-development mainstream (Obrecht & Warner 2016). This paper contributes to this process by conceptualising innovation for humanitarian goals as 'liberatory education' (Freire & Shor 1987). Small-scale projects can have transformative potential and this is realised as innovations are scaled. For this potential to be fulfilled the 'co-participation' of community voices and formal organisations and systems must be sustained throughout the scaling process (Freire 2017). We argue that research hub approaches embedded within multi-stranded strategies are the most effective way of doing this.

We present a framework that visualises innovations as pathways across the adaption-development landscape for humanitarian and development goals. To illustrate and validate this framework we analyse a case study of innovation in aftershock forecasting for humanitarian decision-making. We demonstrate the transformative potential this project had in its 'Invent Stage' (McClure & Gray 2015a & 2015b), and how this began to be fulfilled when the approach was scaled up during the humanitarian response to the Nepal 2015 earthquake (Hope et al 2016). Resource and capacity issues limited this scaling process and we use the adaption-development framework to map out an alternative strategy for AFTER. We conclude by emphasising the value of the framework as an analytical, project management tool, and stress how small-scale innovation initiatives have transformative power when embedded in multi-stranded strategies.

2. Adaption & Innovation for Humanitarian & Development Goals

Adaption theory and innovation theory are both theories of social change. The former focuses on the scope and depth of change, and the latter centres on the initial conditions that create change and the processes by which this is scaled. In Section 2.1, we define adaption, differentiate between adaption modes, and explain their differences by clarifying the relationship between scope and depth of change. In Section 2.2 we introduce innovation into this picture.

2.1. Adaption & Social Change

Adaption theory defines and categorises the changes required for effective response to climate change and its impacts (Gupta et al 2010). It is used to link climate change adaption and risk transition to development and humanitarian goals (Costella et al 2017, Marin & Maess 2017, Begum et al 2014, Bahadur, Ibrahim & Tanner 2013). It has also crossed-over to the development sphere and is being used to frame social change for development in general (Solecki, Pelling & Garschagen 2017, Wise et al 2014, Gibson & Pelling 2014, Pinske & Kolk 2012, Pelling 2011, O'Brien et al 2008).

Within this broad category of action, we can identify a spectrum of adaption modes (Matyas & Pelling 2014, Kates, Travis & Wilbank 2012, Pahl-Wostl et al 2013, Park et al 2012). Resilience building interventions aim to maintain the system in its current form for as long as possible. Resilient

systems when impacted by external shocks are robust enough to bounce back to current levels of functioning. If resilience building is directed towards maintaining the status quo then transformation is found at the other end of the adaption spectrum. Transformative adaption involves deep rooted and fundamental change to current structural relationships (Lonsdale, Pringle & Turner 2015). In climate change terms, this means solutions that address the double injustice of climate change, and engage in a radical re-organisation of the values, lifestyle, economy and governance of current political and economic system (Preston et al 2014). Somewhere in between is the third adaption mode, Transition: This equates with a gradual build-up of modifications that leads over time to more fundamental transformative change (Pelling, O'Brien & Matyas 2015, Loorbach 2010, Loorbach & Rotmans 2003, Rotmans, Kemp & Van Asselt Marjoleia 2001). For example, Chib (2010) describes how a mobile phone app originally developed for Indonesian midwives to receive official health advice and information, led to the mid-wives defining themselves as data analysers not recipients, and developing a sense of collective empowerment. Resilience building transitioned into more fundamental change. Some commentators envisage these adaption choices as a toolbox. All have strengths and weaknesses and the choice of approach will depend on circumstances and context (Pelling 2011). Others are less optimistic about the role of incremental change (resilience & transition modes) in adaption and see it as a way of avoiding the fundamental changes to systems that must be made because of climate change. As Kates, Travis & Wilbanks (2012) put it

> *adaption has largely been envisaged as increments of these adaptions intended to avoid disruptions of systems and as such can act as barriers to the more fundamental change required, p7156*

To explain the difference between adaption modes further and to understand their relationship we can distinguish between the scope and depth of change.

For Termeer et al (2017)

> *Scope generally refers to the scale of that which is changed: as broad scope generally refers to large-scale system wide change, whereas a narrow scope addresses specific elements or subsystems that require change p561*

Expanding the scope of change involves expanding the system level and components included within change processes. Depth of change refers not to the scale of change but,

> *to the level of change: superficial change means improving current practices without altering underlying assumptions, whereas in depth change aims to radically change these practices by altering values, frames and logics underlying the system (Termeer et al 2017 p563)*

For Pahl-Wostl (2009), depth of change is dependent on the learning loops that underpin it (Figure 1).

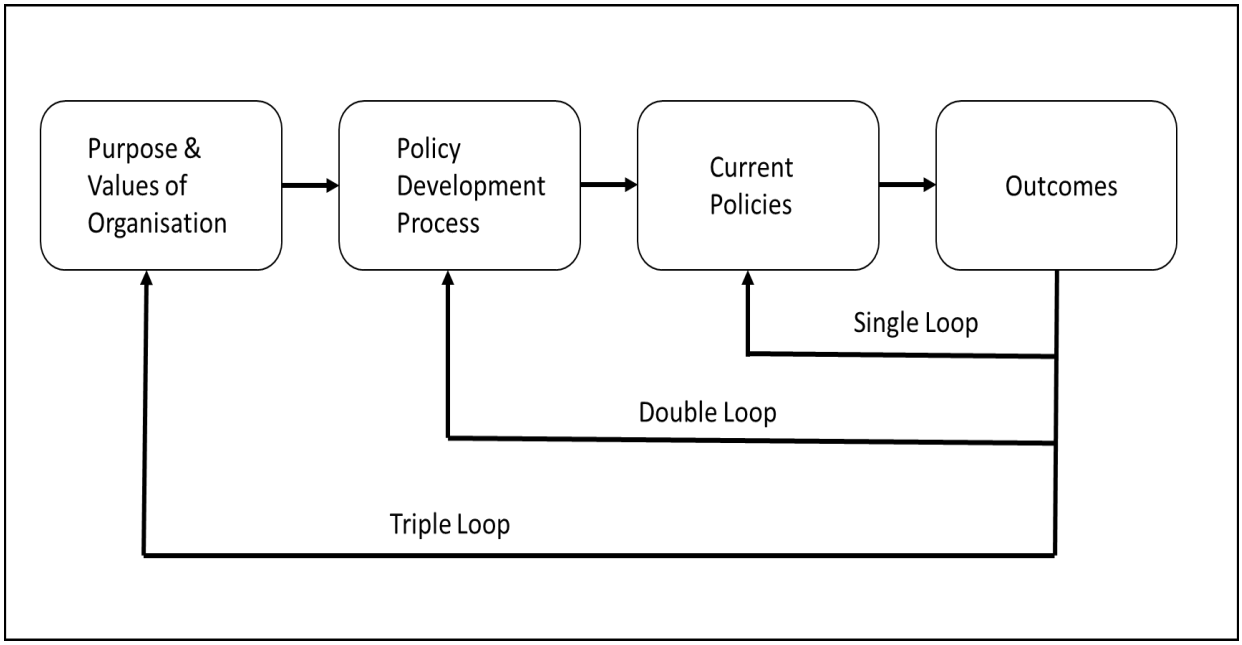

Figure 1: Learning Loops (After Pahl-Wostl 2009)

Organisations that engage in single loop learning reflect on present practice to deliver current policies and programmes more effectively. There is a single loop of learning between programme outcomes and existing policies (Pahl-Wostl 2009). An example from DRM would be a humanitarian organisation that operates a tsunami early warning system for a vulnerable community and recognises the need to improve the scheme's effectiveness by developing better communication links with local political and religious structures. The organisations values, purpose, and structure remain the same (to provide early warnings to save lives) and change is relatively shallow and involves the modification of existing programme delivery so that outcomes are enhanced. These activities equate with resilience building to the extent that actions aim at doing current things better rather than thinking beyond the present paradigm (Pelling, Abeling and Garschagen 2016).

Double loop learning maps onto transition as an adaption mode and onto a deeper level of change. Here core values and ways of working remain untouched but there is critical reflection on both the effectiveness of current policy and the possibilities of alternative pathways to these goals. For example, the humanitarian organisation above reflects on the effectiveness of the early warning system and realises that women are less able to access the early warnings because of the scheme's reliance on existing patriarchal community structures. This initiates critical reflection on existing policies and development of new interventions including a mobile phone app to get the warnings directly to women. This time there are two learning loops. One from outcomes back to current policies and a second from outcomes to the processes that plan and develop policy.

Triple loop learning occurs when an additional loop of learning links outcomes, current policies and the policy planning process to the deepest reflection on the purpose and values of the organisation or group. This may lead to a fundamental transformation in organisational aims, processes and structure (Kates, Travis & Wilbanks 2012, Park et al 2012). In the example above, it becomes clear to the humanitarian organisation that the mobile phone app and related policies have enhanced the agency of local women around tsunami risk and this has spilled over into action and organising by these women around other issues such as health and violence against women. This leads to a rethink within the humanitarian organisation about its fundamental purpose and structure particularly its role as an external agency that delivers humanitarian goals top-down to communities. This results in

transformation to participatory forms of governance in which the community and the humanitarian organisation are partners in multi-stakeholder DRM.

In differentiating between scope and depth of change, Termeer et al (2017) make a valuable contribution to our understanding of the adaption process. However, in limiting scope of change to the vertical incorporation of system levels and components, they exclude the multiple voices and perspectives currently outside current systems and structures that are crucial to critical reflection, triple loop learning and transformative social change. Limiting change in this way is likely to reinforce established silo, and 'ivory tower thinking', and lead to shallow, incremental change (Bloom & Faulkner 2015). To catalyse critical reflection, triple loop learning and deep change, the scope of change must be extended to include the participation of voices and perspectives, outside established systems and structures, in the adaption process. As Paulo Freire puts it, for transformation, there must be co-participation in the act of thinking

> *This co-participation…in the act of thinking is communication. To do otherwise is to rob others of their right to engage in the deepest transformative relationship with the world (Freire 2005 p124)…Authentic thinking that is concerned about reality, does not take place in ivory tower isolation but only in communication (Freire 2017 p50)*

When multiple perspectives are included in the social change process it is less likely to be dominated by a limited number of taken for granted positions. The co-existence of diverse view points means actors are confronted by alternative standpoints that call their own into question (Brookfield 1991). All perspectives become open to questionning and critical reflection, enabling triple loop learning and a fundamental interrogation, negotation and transformation of established social relationships, values and practices (Mezirow 2000). System level change on its own cannot drive adaptive transformation. Multiple voices working together with systemic change are required for the deepest transformative change.

The ongoing development of the Indian Ocean Tsunami Warning and Mitigation System (IOTWMS) is a case in point. The IOTWMS involves significant system-level coordination between 28 national governments (IOTWS n.d.). At the same time, progress has been made in building preparedness and awareness at the community level (Thomalla & Larsen 2010). These approaches will potentially help many people in the event of future devastating tsunamis but deeper social transformation that addresses the social and political reasons why some communities are vulnerable in the first instance is unlikely. To do that community level voices must become active participants in the co-production and governance of early warning systems (EWS), and EWS themselves embedded in deeper projects of social change and development, rather than treated as discrete technical interventions (Hickey & Mohan 2004b). The deepest transformative adaption is dependent on the full and mutual articulation of system levels with multiple voices.

The concepts of adaption and resilience are sometimes used in confusing and contradictory ways (Matyas & Pelling 2015). In this paper we have followed Pelling (2011) and restricted the concept of resilience to actions that preserve the current order. However socio-ecological approaches that use ecological concepts to analyse human-environment interaction utilise the notion of tipping points to link resilience to transformative change (Cote & Nightingale 2012). Argyris & Schon (1996) equate single loop learning with coping (rather than resilience) and second loop learning with adaption (our transition), while Pelling, O'Brien & Matyas (2015) differentiate between resistance, incremental adjustment and transformation. We follow Pelling (2011) in using adaption as the umbrella term, and resilience, transition and transformation as the three alternative pathways within it. We

contend, like Pelling (2011), that this best captures adaption as a contested and unequal socio-political, (rather than socio-ecological), process in which multiple voices work across system levels to engage in learning, critical reflection and drive social change of varying depths.

These relationships are summarised in Table 1. The scope of change has two components; system-levels and voices, and both are present in changes of significant scope and depth. The latter is dependent on the types of learning possible in a given social context, and is driven (at least in part) by the scope of change, in particular the number of different voices engaged in critical reflection on institutions, values and practices. Some forms of resilience building have influence at multiple system levels but there may be few alternative voices engaged in a process of critical reflection on these activities. Transition building approaches will by definition be inclusive of more than one voice. If the resulting critical dialogue extends to multiple system-levels then there may be sufficient scope of change to transition into adaptive transformation (Smith & Stirling 2018). The deepest transformative change is dependent on multiple voices being included in decision-making and learning processes.

Adaption Mode	**Resilience**	**Transition**	**Transformation**
System Levels	Some	More	Many
Voices	Few	Some	Many
Learning Loops	Single	Single Double	Single Double Triple
Change	Scope But Little Depth	More Scope & Depth	Scope & Depth

Table 1: Adaption Modes & Components of Change (After Pelling 2011)

In the next section, we introduce innovation theory into this picture. We argue that it is also a theory of change that focusses on the processes that create and scale new ideas and practices to drive wider patterns of adaption. We show how models from business and management dominate innovation theory, even within the humanitarian and development communities, and this is a barrier to their integration within the adaption paradigm. We suggest an alternative perspective that frames humanitarian-development innovation as 'liberatory education' (Freire & Shor 1987) and innovation teams as sites of transformative potential. Scaling is the addition of system levels and voices to realise this potential in the wider world. There are significant barriers to this process and failure to navigate them can mean the transformative power of innovations is lost or compromised. We use this framework to reveal, explain and categorise alternative innovation pathways across the adaption-development landscape.

2.2. The Adaption-Development Landscape from the Standpoint of Innovation

Innovation theory describes and explains the process by which a new product or service is developed and then delivered at scale. It is of interest to a wide range of academic and policy areas (Dodgson & Gann 2010) and is heavily influenced by business and market perspectives (Pol & Ville 2009). Innovation theory has been a focus for the humanitarian, adaption and development sectors for some time (Scriven 2016, Betts & Bloom 2014, Bloom & Betts 2013, Betts, Bloom & Omata 2012Rodima-Taylor 2012, Rodima-Taylor, Olwig & Chhetri 2012) It offers a relatively simple and appealing way of understanding how change occurs and how to optimise it for humanitarian and development goals (Ramalingham & Bound 2016). These debates have also drawn heavily on perspectives from business and management, (although interesting alternatives include ecological (Ramalingham, Scriven & Foley 2009), and social innovation approaches (Smith & Stirling 2010)).

Business based approaches have made some useful contributions, but misunderstand the goal of humanitarian-development innovation and the process by which this change occurs. We address these limitations in the section below and develop an alternative perspective that presents innovation as a complex emergent socio-political process to drive adaption.

Business and management perspectives focus on product innovation for the market to optimise economic returns (Mulgan et al 2007a, 2007b). Product innovation follows a bell curve (Adner and Leventhal 2001) because the rate of innovation increases over time to a peak then drops off once the optimum product design has been reached. Markets become saturated, and there is a limit to the utility consumers gain from further innovation. Consequently, there is a point where more innovation does not increase economic returns and innovation stops (Adner and Leventhal 2001). The 'Bell Curve Perspective' is influential in the humanitarian and development sectors (Ramalingham & Bound 2016, Gabriel 2014). For example, McClure and Gray (2015a & 2015b) conceptualise humanitarian innovation as a four-stage process that unfolds in a fixed linear sequence. Innovation begins with the Invent Stage that consists of small teams assembled to question existing policy and practice and develop new ideas and ways of working. The second stage is Scaling Up where the emphasis is on developing a sustainable working version of the prototype at scale in a single real world context (e.g. within a single humanitarian or government agency). The rate of innovation rapidly increases at this point as many lessons are learned and adjustments made. Over time, the innovation coalesces around an optimum design. The rate of innovation drops as innovators strip away non-essential elements to create a simplified, uniform product or service (McClure & Gray 2015a & 2015b), that can be Scaled Out to work effectively across multiple social contexts and circumstances. In the final Optimisation Stage, the optimum design is fixed in quality and design standards and innovation all but ceases. Activity is restricted to the monitoring of performance against these standards (McClure & Gray 2015a & 2015b).

In Figure 2 the product design process is plotted against the two components of scope of change (Line 1). After the initial Invent Stage, system level components are swiftly added as the innovation is scaled up within a single official decision-making organisation. Once the optimum design is reached system levels are dropped out. More voices are introduced as the simplified product or service is scaled out to multiple users at local levels. This approach is valid when the goal is economic optimisation and throws useful light on the conditions that enable the invention of new products and services, and the barriers to effective scaling (McClure & Gray 2015a & 2015b). However, it is problematic when used in a humanitarian and development context, as it results in a view that favours top-down central control and a limited policy recipient role for communities. Central authorities develop innovations and steer the resulting policy from 'the cock-pit' (Termeer et al 2017). Local communities are service recipients and their participation is limited to a relatively passive and restricted role around project delivery, risk awareness and mapping or community-level assessments of need (Hickey & Mohan 2004a & 2004b).

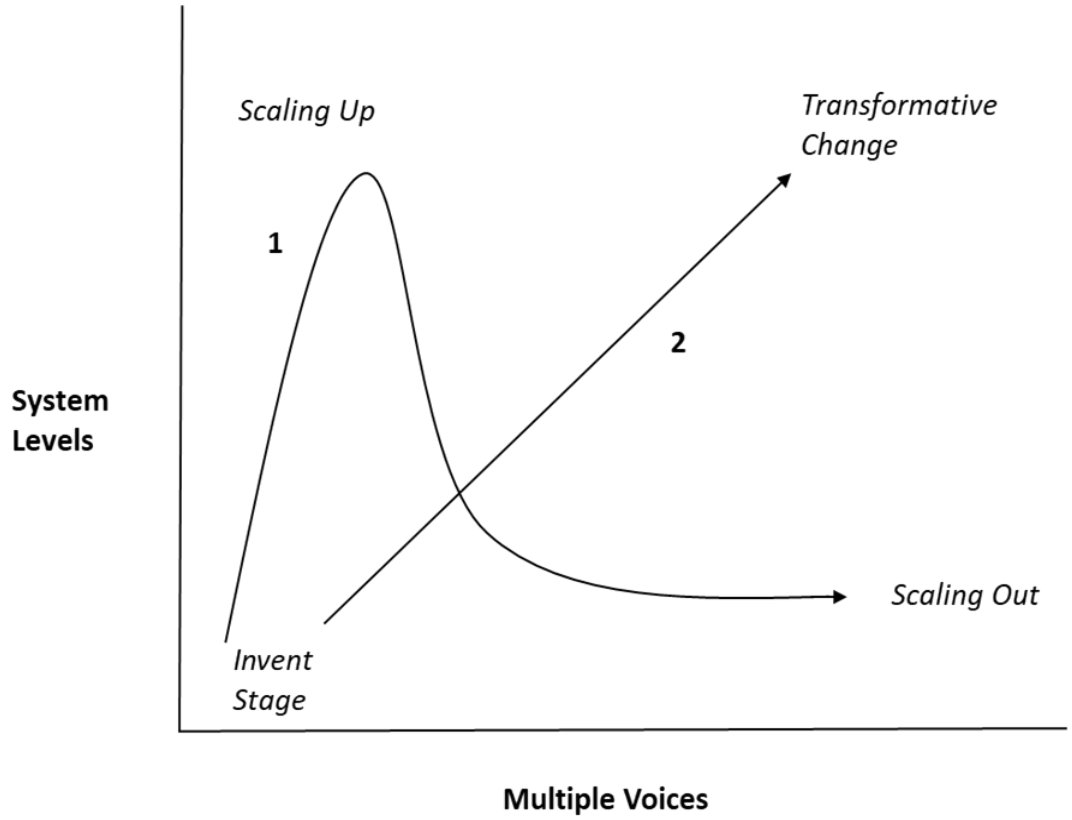

Figure 2: Product Innovation (1) and Innovation for Humanitarian and Development Goals (2) Plotted Against the Components of Social Change (after Freire 2017 and Termeer et al 2017)

Humanitarian and development goals fundamentally differ from economic optimisation, because they are transformational. They are based on a vision of a better world that inspires actions to challenge and transform current circumstances. Freire and Shor (1987) term these 'dreams of transformation'. These anticipate,

> *a society different from the one we have now. (We) imagine alternatives, (and) anticipate a history different from the one we live in now (1987 pp184-185)*

We see these transformative goals in Concern's vision statement, (*a world where no-one lives in poverty, fear or oppression* (Concern n.d)), and can think of the sustainable development goals (SDGs) in these terms (Vandermoortele 2011, Saith 2006). They are present in the humanitarian principles of 'humanity, universality, impartiality, neutrality, and unity' (Human & Robins 2014, Dower 1987, Slim 1998), and the personal wish we have to do something to help others if we can. Transformational goals demand to be realised in as much scope (for as many as possible) and depth (as fully) as possible, and this is achieved through transformative adaption in which system levels and voices are engaged in a balanced, participatory, inclusive process of change (Hickey & Mohan 2004a). Innovation for humanitarian and development goals is the social change process by which system levels and voices are added to move from the Invent Stage to Transformative Change, as in Figure 2, Line 2.

We can develop this further to create a three-dimensional landscape that represents adaption-development from the standpoint of innovation (Figure 3). The height of the contours and the distribution of adaption modes reflect the combinations of scope and depth of change that underpin each region. The most mountainous zone is where humanitarian and development 'dreams of

transformation' are located. The terrain is precipitous because these visions look forward to an ideal state in which all system levels and voices are engaged in genuine multi-stakeholder partnership for transformative change.

In the Invent Zone, the land is low-lying land because Invent Teams are small and reflect only a limited subset of the systems and voices that comprise the landscape as a whole. However if participants are well chosen, they can represent key voices and perspectives, and have the authority and expertise to understand and influence selected established systems. Effective Invent Teams are motivated by 'dreams of transformation' and are a space outside the usual structures, timetable, responsibilities and funding mechanisms. This helps create a critical distance from established values and practices, and a transformative space in which to criticise the status quo and imagine alternatives. For Freire & Shor they

> *illuminate the conditions we're in to help overcome those conditions, offering (participants) a critical distance on society in place of an uncritical immersions in the status quo, to think of changing it (Freire & Shor 1987 p14)*

These three features of Invent Teams (small teams, dreams of transformation and a free space outside the usual structures) are the 'conditions of illumination' that for Freire drive 'liberatory education' and create transformative potential (Freire & Shor 1987, p138). This is only fulfilled through action, by including other system levels and voices within the innovation process.

As Freire & Shor put it,

> *(This)…approach can create conditions for…illumination…but (it) cannot produce more jobs, or conditions for more stable families, or less racism and sexism, or better housing, a reduced arms race, a more democratic college, or even a more appealing school building…Only organised opposition can achieve these goals (1987, p138)*

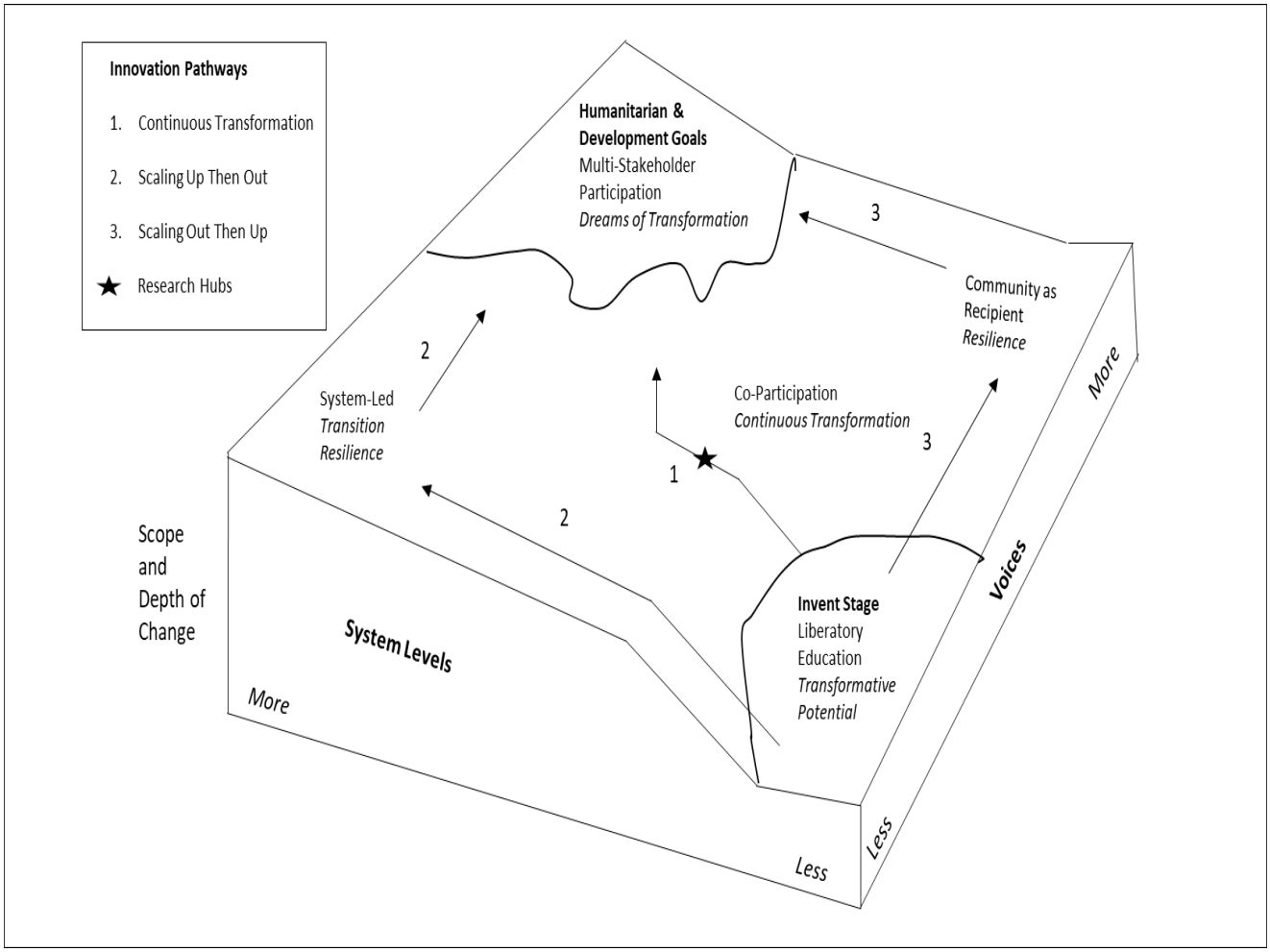

Figure 3: The Adaption-Development Landscape from the Standpoint of Innovation

The System-Led sector is a mid-sized peak where established governmental and NGO actors lead adaption-development activity of some depth. Formal expert voices dominate decision-making conversations and if effective, can bring significant benefits. For example, it is estimated that the state-led deployment of earthquake early warning systems, such as public warning systems in Mexico and Japan, can reduce the number of injuries in earthquakes by 50% (Strauss & Allen 2016). Solutions like these are important in resilience and transition building, but can also be top-down, single perspective solutions that hinder transformative adaption, (or even a barrier if seen as 'job done') (Termeer et al 2017, Bloom & Faulker 2015). The Community-Delivered peak is smaller, as change is shallower, as this quadrant is where multiple participants at community rather than strategic system levels contribute to the delivery of relatively simple adaption-development activities, (increasingly, although not exclusively, using digital technologies (Meier 2015). There are many benefits from these actions. For example, Gilmour (2016) demonstrates the potential of crowd-sourced mapping in a humanitarian crisis as a resilience building strategy, and Sorenson (2016) the value of mobile phone apps in enhancing risk communication regarding the risk of explosive mines during an armed conflict. Crowd-sourcing projects however can reflect and maintain rather than challenge existing social inequalities. Mulder et al (2016) show how marginalised groups were under-represented in the data collection and sharing processes of Big Data projects run during the Haiti 2010 emergency and the Nepal 2015 earthquake. Even when projects are effective, participants can be engaged in relatively simple and passive policy delivery roles (e.g. awareness raising or early warning activities) where there is little opportunity for critical reflection and

participants are far removed from the system levels where the decisions over policy development and resources are being made (Jibiki et al 2016, Hickey & Mohan 2004a). Projects in this zone are orientated towards incremental adaption, and as with the System-Led sector, if pursued uncritically, (as 'ends in themselves'), can become a barrier to transformative change (Morozov 2014).

Innovations can be visualised as pathways to link the regions of the adaption-development landscape. Depending on their direction, these pathways, pull in or off-load scope of change components, enhancing or stripping back depth of change as they go. We can differentiate between and evaluate pathways in terms of the adaption modes they generate, as well as visualise the differing roles they play in multi-stranded adaption strategies. A first option is to embed innovation in strategies that look to balance system level perspectives with other voices at the Invent Stage and maintain this balance throughout the scaling process (Figure 3 Pathway 1). Termeer et al (2017) call this continuous transformation, and argue we should identify existing pockets of transformative change within organisations and groups, and develop interventions to scale them by unblocking barriers and amplifying potential. Research hubs to drive adaption can be considered in this context (Apgar et al 2015, Leach, Scoones & Stirling 2007). Typically, these projects kick-start continuous transformation by bringing together clusters of researchers, community participants, policy makers and government actors, often within a single city or locality, as a critical mass of voices, perspectives and system levels and components. This can be of sufficient scope to boost adaption some distance along the scaling pathway (Starred on Figure 3). CGIAR's research programme on Aquatic Agricultural Systems (AAS) is a good example of this approach (Apgar et al 2017 & 2015 and Apgar & Douthwaite 2013). The AAS hubs embedded research programmes within larger development projects, initially at the city level, and then scaled to address poverty and drive transformative adaption (Apgar et al 2017 & 2015). Participatory Action research (PAR) was used to balance system level actors and community participants from the beginning of the innovation process (Douthwaite et al 2013). Scaling occurred in a process of continuous transformation that moved through nested levels of voices and systems

> *…to unleash the systems potential for change and innovation…through facilitating the interaction of multiple actors…across scales (Douthwaite et al 2013 p18)*

These approaches developed adaptive forms of management; set short-term goals, and used continuous monitoring to ensure that projects were not locked into linear paths, but agile enough to change direction as new voices and system components were added over their lifetime (Hobbs & Petit 2017, Derbyshire & Donovan 2016).

Other innovations for humanitarian and development goals start by either Scaling Up or Scaling Out and then look to introduce the missing voices or system levels required for transformative change, at some point further along the route (Figure 3, Pathways 2 & 3). From Scaling Up one way to complete the journey to deeper change is to find ways to transfer decision making from existing system levels and organisations to communities and NGOs, to create broad based and balanced multi-stakeholder participation (Pathway 2). Examples here include the case studies of successful innovation in participatory local governance given in Blair (2008), (although see the critique in Platteau (2008)). Real Time Evaluations (RTE) are an example from DRM. These are frequently deployed by humanitarian organisations in crises situations to give immediate feedback to system level actors on the effectiveness of their response. Often these are workshops with key stakeholders in the field, that take place in the first few weeks after an emergency and are run by facilitators from humanitarian headquarters (Polastro 2011). In such cases the potential for transformative change is

limited as the main goal is to improve the effectiveness of existing system-led programming. However Polastro (2011) cites examples of RTEs conducted during the Pakistan floods of 2010 and Mozambique floods and cyclones of 2007 that became 'owned' by local teams and actors, contributed to enhanced learning and accountability between system levels and community voices and were a potential pathway to Scaling Out and deeper change.

Scaling Out strategies (Pathway 3) aimed initially at simple resilience building, (e.g. mobile phone technology to improve health programmes), can, for example, go on to enhance women's empowerment more generally (Jennings & Gagliadi 2013). Demonstration of effective resilience building (in initially neutral and non-political ways), can create entry points with communities and government actors , for more complex tasks involving critical reflection that challenge existing values and ways of working, and in time may open the door to genuinely participatory governance to drive transformative change (Hellstrom 2015). Community Risk Assessments (CRA) and Participatory Disaster Risk Assessments (PDRA) are examples from disaster risk management. Humanitarian and related agencies frequently scale out standardised and fairly simple workshopping, survey and mapping methodologies for communities to use in the first few weeks following a disaster (Moss 2007, Pelling 2007). Communities take an active role in producing local level assessments of need and damage that feed into system level decision making. They can provide useful knowledge but restrict the community to a limited information gathering and policy recipient role (Moss 2007, Pelling 2007, Hickey & Mohan 2004a & 2004b). Sometimes however, participation in these activities can catalyse community learning and capacity for critical reflection on the causes of vulnerability, and Haghebaert (2007) gives examples from South Zambia and El Salavador of CRAs that helped open a pathway for community voices to be scaled up and included in multi stakeholder governance and deeper social change (Haghebaert 2007, Pelling 2007).

Innovation for humanitarian and development goals tends to follow the established pathways of Research Hubs, Scaling Up then Out, and Scaling Out then Up. However, the humanitarian-development landscape as we have presented it can be crossed in numerous ways that unfold in complex combinations. Ramalingam, Scriven & Foley (2009) capture this in the context of humanitarian innovation

> *(T)he sources of ideas and the drivers of the process have become increasingly diffuse. In particular, open democratised innovation models suggest that many of the most radical innovations come not from experts and specialists in R & D but from the front-line staff, consumers, users and suppliers-those traditionally excluded from innovation processes (Ramalingam, Scriven & Foley 2009 p30)*

In practice, there is a non-uniform distribution of voices and system levels amenable to change across the adaption-development landscape, and we picture the most effective innovation strategy as a complex, emergent multi-stranded programme that simultaneously 1. Kick starts deep change using Research Hubs 2. Steers selected existing incremental strategies in a transformative direction 3. Uses existing incremental strands to input into and support the overall strategy of transformative change, and 4. Recognises, amplifies and unblocks ongoing sources of continuous transformation

We have developed a conceptual framework to visualise the adaption-development landscape and innovations as pathways across it for humanitarian and development goals. In the next section, we illustrate and validate this approach as a tool to map, analyse and co-ordinate pathways by analysing a case study of innovation in aftershock risk forecasting for DRM. The project had some of the features of Freire's concept of 'liberatory education' and was used as part of the humanitarian response to the Nepal 2015 earthquake (Hope et al 2016). We show how this enlarged scope and

depth of change, and how resource and capacity issues hindered this process. We use the conceptual framework to identify pathways and strategies to move the innovation forward.

3. Case Study: Innovation in Aftershock Forecasting for Disaster Risk Management

3.1 The AFTER Project

AFTER was an innovation project that ran from December 2013 to July 2017 based on a partnership between Concern Worldwide (a Dublin based international humanitarian organisation), and the University of Edinburgh School of Geosciences. The project's aim was to invent an aftershock forecasting approach for humanitarian and development organisations to use in the days and weeks following a major earthquake to improve decision making around aftershock risk. The project had three phases each corresponding to a different stage of the innovation pathway (Table 2).

Title of Project Phase	Dates	Stage in Innovation Pathway
1. An NGO Administered Near Real Time Aftershock Forecasting Tool for Humanitarian Risk Assessment and Emergency Planning	December 2013-May 2014	The Invent Stage Developing Transformative Potential
2. The Completion and Testing of an Aftershock Forecasting Tool for Emergency Response	January 2015-June 2016	Scaling Transformative Potential Adding New System Levels and Voices
3. Research for Emergency After Shock Response	November 2016-July 2017	Strategies for Scaling Up & Out

Table 2: AFTER: Phases, Dates & Stages of Innovation Pathway

The Invent Phase developed the forecasting approach and explored its transformative potential in a small innovation space outside of usual patterns of work. In the second phase Concern staff used the approach during their response to the April-May 2015 earthquake in Nepal. This real-world application introduced new system levels and voices into the innovation process and initiated the scaling of the transformative potential of the approach. This revealed opportunities for rapid learning and barriers and challenges to scaling up and out. The third phase aimed to address these issues by exploring strategies to scale up the approach to decision-making levels of government, humanitarian and development organisations, and scale it out using mobile phone app and online learning based methodologies.

Qualitative evidence was gathered in one to one interviews and by taping and transcribing training sessions and workshops. Interviews and discussions were conducted with the participants listed in Table 3, and numbers of interviews and taped discussions are given in brackets. The qualitative evidence was analysed to understand 1. The dreams of transformation that motivated participants and the structure and characteristics of the Invent Stage. 2. The processes by which voices and systems levels were added during the Nepal earthquake and the challenges and opportunities for scaling this created and 3. The extent to which Phase 3 activities addressed these challenges. We use this analysis to plot the project on the innovation landscape and in Section 4 map an alternative pathway to realise its transformative potential.

Research Participants with Number of Taped Interviews & Discussions in Brackets
• Concern DRR Advisor and Emergency Response Co-ordinator in Nepal (>25) • Concern Head of Emergency (>25) • Lead Geo-Scientist, University of Edinburgh (>25) • 2 x Post-Doctoral Earthquake and Aftershock Modellers (12 each) • Professor of Geoscience and Lecturer in Geoscience University of Edinburgh (both 3) • Concern Emergency Director in 205 Nepal earthquake (2) • Member of Concern Emergency Response Team in 2015 Nepal earthquake (1) • DRR consultant (1) & Senior Manager of International Humanitarian Organisation (1) • Professor of Geoscience USA (1) & Professor of Geoscience Italy (1)

Table 3: Research Participants

3.2 The Invent Stage and Scaling Transformative Potential

In Section 2, we conceptualised innovation for humanitarian and development goals as a process of social change in which small teams, driven by transformative goals and outside the usual patterns and constraints of work, engage in triple loop learning, to create innovations that drive adaption. This transformative potential is realised by scaling when real world systems and voices are added into the innovation process. In this section, we use the AFTER example to illustrate this approach at work and demonstrate the value of framing innovation for adaption in this way.

3.2a: The Invent Stage: The early phase of the project had many of the features of the Invent Stage visualised in Figure 3. The team was small (Table 3) with three Scientists and two Humanitarian staff comprising the core group. This expanded during and immediately after the Nepal 2015 emergency to a further eight participants (4 scientists and 4 humanitarian staff). The core participants and many of the wider group had senior positions within their respective scientific and humanitarian organisations, but at this stage of the innovation process, only a small number of potential voices and system levels were part of the process.

AFTER was 'more than a job'. People were motivated by transformative humanitarian and development goals. The continued loss of life to earthquakes shocked participants, they wanted something better and had become involved to realise this in as much scope (for as many people) and depth (as fully) as possible. The comment below was typical

> *I saw the devastation in Ache in 2004, and I thought…we need to get ourselves organised and do something to help….there must be ways of helping humanitarian organisations in situations like this (Science Participant)*

The project was funded by three UK research council grants rather than by the organisations participants worked for 'in their day job'. This put it, in some ways, outside the usual pattern of work. This created time out and a free space in which new ideas and ways of working were critically explored. As one participant put it

> *I looked forward to getting on the bus…and getting up there. It gave me thinking time. Time out to do something different and creative and I'd get a lot done. Not just about earthquakes! (Humanitarian Participant)*

This was an opportunity to critically reflect on and interrogate current practice. To engage in triple loop learning and imagine alternatives beyond current policy and practice

It became part of an ongoing process for us, where we pause and reflect on what we are doing. Is there anything we are missing? Are there things we can do better? (Humanitarian Participant)

By the end of the Invent Stage, the project had considerable transformative potential

At that point, we were ready with the calculations. We had the people in place and the science to make the forecasts in near real-time. We were ready to rock and roll! (Humanitarian Participant)

3.2b Scaling Transformative Potential: The 2015 Nepal earthquake drove rapid learning on aftershock risk as the project began to add in system levels and voices. Scaling up began when Concern's safety and security guidelines were rewritten in response to the forecasts and Concern's international staff in Nepal were included in these revised briefings (Hope et al 2016). This was quickly extended to include Concern's local Nepalese partners

It became really important when we were working with our partner organisations in Nepal. I went through the whole briefing with them-encouraged them to go and buy tents and whistles and charge it to Concern-to stay out of buildings and make sure their staff were safe (Humanitarian Participant)

Enlarging the scope of change drove critical reflection and depth of change particularly around the communication of risk

When Nepal happened what we weren't ready with was the communication strategy, so over the period of a month or so when we worked pretty much every day on the earthquake, we started developing our communication strategy. We were sending stuff and they were saying 'this is great', but I don't want to see these diagrams and we negotiated should the graphs be included at all and so on. That sort of thing went on through the month and we ended up with a living document (Science Participant)

Other attempts to scale up the innovation in Nepal were not as successful. Participants tried to share the forecasts with staff at strategic decision-making levels in UNOCHA (The United Nations Office for the Coordination of Humanitarian Affairs) who were organising the whole of the humanitarian response

One thing that I wanted to do was to go and talk to the humanitarian coordinator in UNOCHA. And I was saying 'I want to get a meeting with this guy and talk to him about what AFTER has said', but it never came together, we just ran out of time, and then my contact left and so I lost the way in that I had (Humanitarian Participant)

Similar limits of capacity and authority hampered efforts to share forecasts with the wider Nepali community

When it came to the disaster-effected communities, I had no authority at all. The only thing I could do was risk awareness. To sit down and say 'look I've received information that the risk of an aftershock remains high and I understand that you are living outside in tents, but my advice is that you don't go back into still standing buildings because they are probably very dangerous if there is an

aftershock. But I can't give you an order!' I couldn't say any more than that and I saw a lot of scepticism on people faces (Humanitarian Participant)

The aftershock forecasting approach made a useful contribution to Concern's decision making in Nepal as system levels and voices began to be included in the innovation process. This stalled when limits of capacity and authority were reached.

3.3 Scaling Up & Out

The third phase addressed some of these issues (Table 2). Scaling Up was approached in two ways. 1. Activities to access decision makers in strategic level organisations such as the UN and National Governments. Team members presented at the United Nations Office for Disaster Risk Reduction (UNISDR) Global Platform 2017 in Cancun in May 2017 and to UNESCO in Paris in June 2017. Partnerships with the Turkish Disaster and Emergency Management Authority (AFAD), the Asian Preparedness Centre (ADPC) and the Global Network of Civil Society Organisations for Disaster Reduction (GNDR) were developed. 2. Activities were run to include a wider network of humanitarian organisations in the programme, including aftershock training in July 2017 with the START Network (Start (n.d)). Scaling Out was initiated through a collaboration with the Centre for Research in Digital Education (CRDE), University of Edinburgh to develop mobile phone and online learning tools to promote hazard awareness and warning. Also explored were technical issues around community mobile phone use to improve forecasting accuracy by measuring ground shaking in real time.

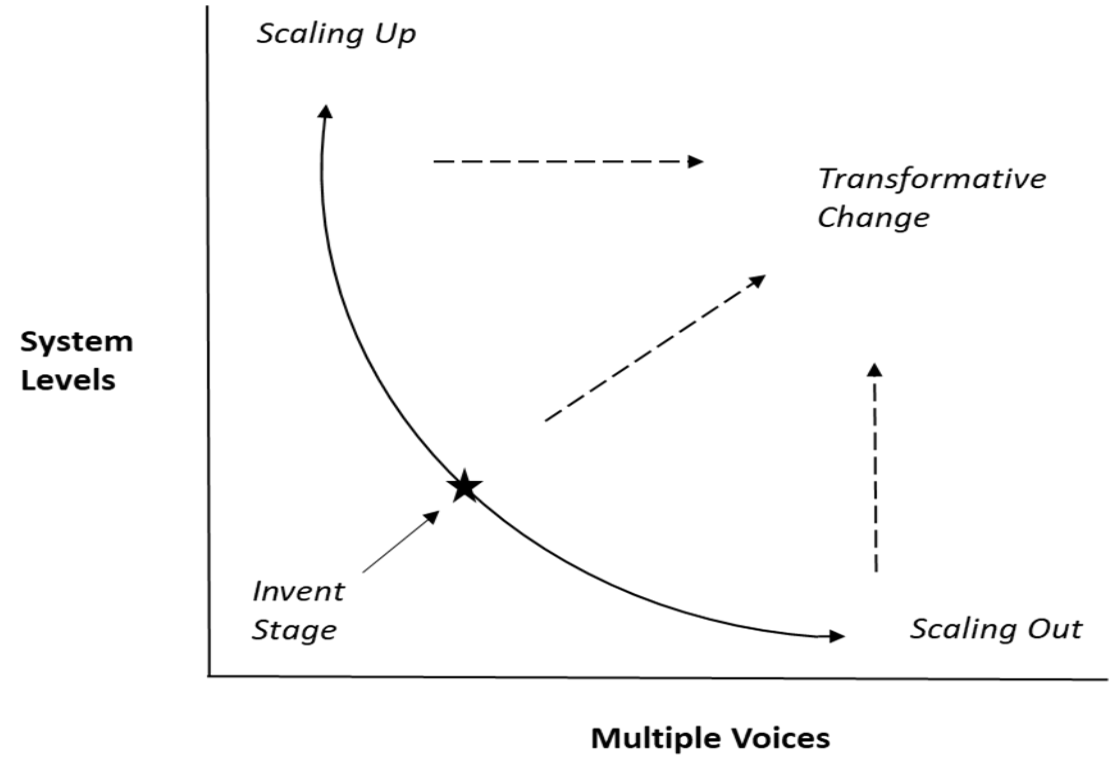

Figure 4: AFTER Plotted Against Scope of Change Components

Figure 4 plots AFTER against the two components of scope of change. The Nepal experience (starred) was a catalyst that added in system levels and voices and pushed the curve upwards towards deeper change. The projects with the UN, AFAD, START and the CRDE have the potential to extend the line vertically and horizontally. This is valuable ongoing work but the goal of transformative change remains some way off. A key implications of the framework developed in Section 2 is that even if

capacity and authority issues of the type seen in Nepal are resolved, these strategies will not deliver transformative adaption. Activities to scale up can stall in the System-Led quadrant of the adaption-development landscape and community level approaches to scaling out have a limited ability to deliver transformative change. In the final section below, we reflect on the contribution of this approach to innovation and adaption theory and conclude by using the adaption-development framework to map out an alternative multi-stranded strategy for AFTER.

4. Conclusion: Innovation Pathways to Adaption for Humanitarian and Development Goals

Innovation is a vital aspect of social change but often sits outside key debates on adaption and transformation. In this paper we have developed a framework that better integrates innovation with the language and concepts of adaption and development. From our perspective, innovations are adaption processes that can deliver humanitarian and development goals. The kind of adaption produced depends on the type and balance of system levels and voices pulled into the innovation process as its scales up and out. We have used an example from DRM to illustrate and validate the approach and have demonstrated how the framework can better link DRM innovation pathways to development goals and adaption modes. In so doing we contribute to ongoing work to integrate DRM and climate change adaption, rather than treat them as separate realms of policy and theory (Begum et al 2014, Gibson & Pelling 2014). An example of innovation in climate change adaption or development policy would have worked just as well, for the framework succesfully captures the nexus between innovation, adaption, DRM and development (Begum et al 2014, Wise et al 2014, O'Brien et al 2008).

In advancing this approach, we have developed a nuanced reading of the relationship between incremental and transformative change. The choice of incremental or transformative strategy is not a neutral technical question of selecting the right tool for the job (Pelling 2011). For strategies that emphasise systems over voices (Scaling Up), or voices over systems (Scaling Out) can (if uncritically applied) be a barrier to deeper change. At the same time, incremental scaling strategies are not locked into an antagonistic relationship with fundamental change, for as we have seen, they can be a valuable element in a multi-stranded strategy aimed at transformative change (Kates, Travis & Wilbanks 2012). Instead, we present a more complex landscape of incremental and transformative regions, strategies and options, with dead ends and cul-de-sacs that we can navigate, and pathways combined to maximise transformative change (Figure 3).

The AFTER example demonstrates the frameworks ability to reveal, evaluate and co-ordinate specific innovation pathways for humanitarian and development goals, and visualise strategies to move particular innovations forward. It gives a critical perspective to support the composition and development of effective invent teams, inform decisions on what voices and systems to include when scaling (and who to avoid), and how to maintain their co-participation throughout this process. It is also a map on which to plot the initial direction of travel (e.g. scaling up or scaling out), at which point to pick up additional voices and system levels, (and offload others), and when to change direction to maximise transformative potential. The deepest implication of the framework is that we can travel simultaneously in multiple directions across the adaption-development surface. The most effective strategy is therefore for multiple strands and hubs to move concurrently and cumulatively towards humanitarian and development goals. AFTER, in these terms, would be part of a larger multi-stranded strategy directed at transformative change working both within and outside transformative research hubs. This would have two elements.

First, *to work within transformative research hubs* to a. Set aftershock risk reduction activity within a wider and deeper development strategy, linking transition out of aftershock risk with, for example, strategies to reduce poverty and social exclusion (Douthwaite et al 2013). b. Use Participatory Action Research (PAR) to achieve a balance of community and system level participants from the beginning of the innovation process (Apgar et al 2017 & 2013, Ensor et al 2018, Hickey & Mohan 2004b). c. Maintain this balance through the scaling process by moving through nested levels of voices and systems, from community to national and international levels (Douthwaite et al 2013). d. Ensure adaptive management so that project aims can change over the course of the project to reflect shifts of direction as new voices and system levels components are added (Apgar et al 2017).

Second*, to work outside transformative research hubs* to a. Continue to pursue vertical scaling of AFTER within National Government actors and International NGOs and, by exemplifying and showcasing good practice, lever and build similar depth and scope of change within, for example, Southern NGOs and other organisations working at strategic levels outside of 'mainstream actors'. b. Deliver a scaling out strategy to demonstrate effective incremental change with multiple community partners, and open the door, (for example through PAR), to deeper forms of community-led learning and adaption, that can be scaled up into formal organisational structures. c. Identify existing islands of continuous transformation around aftershock and related risk, and work to unblock, support and amplify their transformative potential.

Small innovation teams don't sit outside this adaption process, nor are they too small to make a difference. As the AFTER example shows, small-scale innovation activity can have transformative power and following Freire & Shor (1987), the challenge is to think

> *Broadly about the channels through which any group can display transformation. If (we) don't think in terms of phases, levels and gradations in a long process of change, (we) may fall into the paralysing trap of saying that everything must be changed at once or it isn't worth trying to change anything at all. Looking only for big changes, (we) may lose touch with the transformative potential in any activity p35*

Bibliography

Adner R and Levinthal D (2001) Demand Heterogeneity and Technology Evolution: Implications for Product and Process Innovation, *Management Science*, Vol 47, No 5, 611-628

Argyris C and Schon D (1996) *Organisational Learning II: Theory Learning and Practice*, London, Addison-Wesley

Apgar M, Allen W, Albert J, Douthwaite B, Paz Ybarnegaray and Lunda J (2017) Getting Beneath the Surface in Program Planning, Monitoring and Evaluation: Learning from use of Participatory Action Research and Theory of Change in the CGIAR Research Program on Aquatic Agricultural Systems, *Action Research*, Vol 15, No1, 15-34

Apgar M, Ekong J, Sarapura S and Douthwaite B (2015*) Strengthening Capacities for Research in Development in Aquatic Agricultural Systems, Penang, Malaysia*: CGIAR Research Program on Aquatic Agricultural Systems, Working paper: AAS-2015-14

Apgar M and Douthwaitre B (2013) *Participatory action research in the CGIAR Research program on Aquatic Agricultural Systems*, CGIAR Research Programme on Aquatic Agricultural Systems, Penang, Malaysia, Programme Brief, AAS-2013-27

Bahadur AV, Ibrahim M and Tanner T (2013) Characterising Resilience: Unpacking the Concept for Tackling Climate Change and Development, *Climate & Development*, Vol 5 No 1, 55-65

Begum AR, Sujahangir Kabir Sarkar Md, Jaafar AH and Pereira JJ (2014) Towards Conceptual Frameworks for Linking Disaster Risk Reduction and Climate Change Adaption, *International journal of Disaster Risk Reduction*, Vol 10, 362-373

Betts A and Bloom L (2014) *Humanitarian Innovation: the State of the Art,* Occasional Policy Paper, OCHA Policy and Studies Series

Betts A, Bloom L and Omata N (2012) *Humanitarian Innovation and Refugee Protection,* Working Paper series no 85, Refugee Studies Centre, Oxford Department of International Development, University of Oxford

Blair H (2008) Innovation in Participatory Local Governance, in UN (Eds) *Participatory Governance and the Millennium Development Goals (MDGs)*, New York, DESA

Bloom L and Faulkner R (2015) *Innovation Spaces: Transforming Humanitarian Practice in the United Nations*, Refugee Studies Centre, University of Oxford, Working Paper Series No. 107

Bloom L and Betts A (2013) *The Two Worlds of Humanitarian Innovation*, Refugee Studies Centre, University of Oxford, Working Paper Series No. 107

Brookfield S D (1991) *Developing Critical Thinkers: Challenging Adults to Explore Alternative Ways of Thinking and Acting,* New Jersey, Wiley

Chib A (2010) The Aceh Besar Midwives with Mobile Phones Project: Design and Evaluation Perspectives Using the Information and Communities Technologies for Healthier Development Model, *Journal of Computer-Mediated Communication,* Vol 15, 500-525

Concern (n.d) *Concern's Identity, Vision, Mission and Values* [Internet], Available from: <https://www.concern.net/sites/default/files/html/reports/2013/feature_207.html> [Accessed 28th May 2018]

Costella C, Jaime C, Arrighi J, Coughlan de Perez E, Suarez P and van Aalst (2017) Scalable and Sustainable: How to Build Anticipatory Capacity into Social Protection Systems, In Courting Catastrophe? *Humanitarian Policy and Practice in a Changing Climate,* IDS Bulletin, Vol 48, No 4, 31-46

Cote M & Nightingale A J (2012) Resilience Thinking Meets Social Theory: Situating Social Change in Socio-Ecological Systems (SES) Research, *Progress in Human Geography*, Vol 36(4), 475-489

Derbyshire H and Donovan E (2016) *Adaptive Programming in Practice: Shared Lessons from the DFID-funded LASER and SAVI*, Department of International Development

Dodgson M and Gann D (2010) *Innovation: A Very Short Introduction,* Oxford, Oxford University Press

Douthwaite, B, Kamp, K, Longley C, Kruijssen F, Puskur R, Chiuta, T, Apgar, M, Dugan, P. (2013) CGIAR Research Program on Aquatic Agricultural Systems, Penang, Malaysia. Working Paper

Dower N (1997) Human Rights and International Relations, *The International Journal of Human Rights,* Vol 1, No 1, 86-111

Ensor J E, Park S E, Attwood S J, Kaminski A M and Johnson J E (2018) *Can Community-Based Adaption Increase Resilience?*, *Climate and Development*, Vol 10, No 2, 134-151

Foresight (2012*) Reducing Risks for Future Disasters: Priorities for Decision makers: Executive Summary*, The Government Office for Science, London

Freire P (2017) *Pedagogy of the Oppressed*, London Penguin Books

Freire P (2005) *Education for Critical Consciousness*, London, Continuum

Freire P & Shor I (1987) *A Pedagogy for Liberation: Dialogues on Transforming Education*, London Macmillan

Gabriel M (2014) *Making it Big: Strategies for Scaling Social Innovations*, NESTA

Gibson T D and Pelling M (2014*) Pathways of Transformation: Disaster Risk Management to Enhance Development Goals*, Background Paper, prepared for the 2015 Global Assessment Report on Disaster Risk Reduction, UNISDR

Gilmour E (2016) Mapping for resilience: Crowd-Sourced Mapping in Crises, in Scriven K (2106) Special Edition on Humanitarian Innovation, *Humanitarian Exchange*, Vol 66, 33-35

Gupta J, Termeer C, Klostermann J, Meijerink S, can Den Bink M, Jong P, Nooteboom S & Bergsma (2010) The Adaptive Capacity Wheel: A method to assesses the inherent characteristics of institutions to enable the adaptive capacity of society, *Environmental Science & Policy*, Vol 13, 459-471

Haghebaert B (2007) Working with Vulnerable Communities to Assess and Reduce Disaster Risk, *Humanitarian Exchange,* Vol 38, 10-13

Hellstrom J (2015) Crowdsourcing as a Tool for Political Participation: The Case of Ugandawatch, *International Journal of Public Information Systems*, Vol 1, 1-19

Hickey S & Mohan G (2004a) Towards Participation as Transformation: Critical Themes and Challenges, Chapter 1 in Hickey S and Mohan (Eds) *Participation: From Tyranny to Transformation?* London, Zed Books

Hickey S & Mohan G (2004b) Relocating Participation Within A Radical Politics of Development: Insights from Political Action & Practice, Chapter 10 in Hickey S and Mohan (Eds) *Participation: From Tyranny to Transformation?* London, Zed Books

Hobbs P and Petit Y (2017) Agile Methods on large Projects in Large Organisations, *Project Management Journal,* Vol 48, No 3, 3-19

Hope M, McCloskey J, Hunt D & Crowley D (2016) Integrating Aftershock Forecasting Into Humanitarian Decision Making: Lessons from Nepal, *Humanitarian Exchange*, Available from: <http://odihpn.org/blog/integrating-aftershock-forecasting-into-humanitarian-decision-making-lessons-from-the-april-2015-nepal-earthquake/> [Accessed 28th May 2018]

Human O and Robins S (2014) Social Movements and Biopolitical States: A Study of Humanitarian Aid in Cape Town 2008, *Culture and Organisation*, Vol 20, No 2, 121-134

IOTWS (n.d.) *Indian Ocean Tsunami Information Center* [Internet]. Available from: http://iotic.ioc-unesco.org/indian-ocean-tsunami-warning-system/16/what-is-iotws [Accessed 10th August 2018]

Jennings L and Gagliandi L (2013) Influence of Mhealth Interventions on Gender Relations in Developing Countries, *International Journal for Equity in Health*, Vol 12, No 85

Jibiki Y, Kure S, Kuri M and Ono Y (2016) Analysis of Early Warning Systems: The Case of Super-Typhoon Haiyan, *International journal of Disaster Risk Reduction*, Vol 15, 18-24

Kates RW, Travis WR and Wilbanks TJ (2012) Transformational Adaption When Incremental Adaptions to Climate Change Are Insufficient, *Proceedings of the National Academy of Sciences of the United States of America*, Vol 109, No 19, 7156-7161

Loorbach D (2010) Transition Management for Sustainable Development: A Prescriptive, Complexity-Based Governance Framework, *Governance: An International Journal of Policy, Administration & Institutions*, 23, 1, 161-183

Loorbach D and Rotmans J (2003) The Practice of Transition Management: Examples and Lessons from Four Distinct cases, *Futures,* 42, 237-246

Leach M, Scoones I and Stirling A (2007*) Pathways to Sustainability: An Overview of the STEPS Centre Approach*, STEPS Approach paper, Brighton, STEPS Centre

Lonsdale K, Pringle P & Turner B (2015) *Transformational Adaption: What it is, Why it Matters and What is Needed,* UK Climate Impacts Programme, University of Oxford, Oxford UK

Marin A and Maess LO (2017) Climate Change Adaption Through Humanitarian Aid? Promises, Perils and Potentials of the 'New Humanitarianism', In *Courting Catastrophe? Humanitarian Policy and Practice in a Changing Climate*, IDS Bulletin, Vol 48, No 4, 15-30

Matyas D & Pelling M (2014) Positioning Resilience for 2015: The role of Resistance, Incremental Adjustment and transformation in Disaster Risk Management Policy, *Disasters*, Vol 39, 1-18

McClure D and Gray I (2015a) *Scaling: Innovations Missing Middle,* [Internet], Available from <https://assets.thoughtworks.com/articles/scaling-innovations-missing-middle-dan-mcclure-ian-gray.pdf> [Accessed 28th May 2018]

McClure D and Gray I (2015b) *Managing the Journey to Scale Up Innovation*, [Internet], Available from https://www.thoughtworks.com/insights/blog/managing-journey-scale-innovation [Accessed 28th May 2018]

Meier P (2015) *Digital Humanitarians: How Big Data is Changing the face of Humanitarian Response,* London, CRC Press

Mezirow J (2000) Learning to Think Like an Adult: Core Concepts of Tranformation Theory, Chapter 1 in Mezirow J (Ed) *Learning as Transformation: Critical Perspectives on a Theory in Progress,* San-Francisco, Jossey-Bass

Morozov E (2014) *To Save Everything, Click Here: Technology, Solutionism and the Urge to Fix Problems That Don't Exist*, London Penguin

Moss S (2007) Christian Aid and Disaster Risk Reduction, *Humanitarian Exchange*, Vol 38, 15-18

Mulgan G, Tucker S, Ali R and Sanders B (2007a) In and Out of Sync: The Challenge of Growing Social Innovations, NESTA

Mulgan G, Tucker S, Ali R and Sanders B (2007b) *Social Innovation: What it is, Why it Matters and How can it be Accelerated,* Skoll Centre for Social Entrepreneurship Working Paper, University of Oxford

Mulder F, Ferguson J, Groenewegen P, Boersman K and Wolberg J (2016) Questioning Big Data: Crowdsourcing Crisis Data: Towards an Inclusive Humanitarian Response, *Big Data & Society*, 1-13

O'Brien K, Sygna L, Leichenko R, Adger WN, Barnett J, Mitchell T, Schipper L, Tanner T, Vogel C and Montreux C (2008) *Disaster Risk Reduction, Climate Change Adaption and Human Security*, Report Prepared for the Royal Norwegian Ministry of Foreign Affairs by the Global Environmental Change and Human Security (GECHS) Project, GECHS Report 2008:3

Obrecht A and Warner A T (2106) *More Than Just luck: Innovation in Humanitarian Action*, HIF/ALNAPO Study, London, ALNAP/ODI

Pahl-Wostl C (2009) A Conceptual framework for Analysing Adaptive Capacity and Multi-level learning Processes in Resource Governance Regimes, *Global Environmental Change*, Vol 19, 354-365

Pahl-Wostl C (2007) Transitions Towards Adaptive Management of Water Facing Climate and Global Change, *Water Resource Management,* Vol 21, 49-62

Pahl-Wostl C, Becker G, Knieper C & Sendzimir J (2013) How Multi-Level Societal Learning Processes Facilitate Transformative Change: A Comparative Case Study Analysis on Flood Management, *Ecology & Society*, Vol 18, No 4, 58 http://dx.doi.org/10.5751/ES-05779-180458

Park SE, Marshall NA, Jakku E, Dowd AM, Howden SM, Mendham E & Fleming A (2012*)* Informing Adaption Responses to Climate Change Through Theories of Transformation, *Global Environmental Change,* Vol 22, 115-126

Pelling M (2011) *Adaption to Climate Change: from Resilience to Transformation,* London, Routledge

Pelling M (2007) Learning from Others: The Scope and Challenge for Participatory Disaster Risk Assessment, *Disasters*, Vol 31(4), 373-385

Pelling M, Abeling T and Garschagen M (2016) Emergence and Transition in London's Climate Change Adaption Pathways, *Journal of Extreme Events*, Vol 3, No 3, https://doi.org/10.1142/S2345737616500123

Pelling M, O'Brien K and Matyas D (2015) Adaption & Transformation, *Climate Change*, Vol 133, 113-127

Pinkse J & Kolk A (2012) Addressing the Climate Change-Sustainable Development Nexus: The Role of Multistakeholder Partnerships, *Business & Society*, Vol 51, No 1, 176-210

Platteau JP (2008) Pitfalls of Participatory Development in UN (Eds) *Participatory Governance and the Millennium Development Goals (MDGs)*, New York, DESA

Polastro R (2011) Real Time Evaluations: Contributing to System-Wide Learning and Accountability, *Humanitarian Exchange*, Vol 52, 10-13

Pol E and Ville S (2009) Social Innovation: Buzz Word or Enduring term? *The Journal of Socio-Economics*, Vol 38, 878-885

Preston I, Banks N, Hargreaves K, Kazmierczak A, Lucas K, Magre R, Downing C and Street R, (2014) *Climate Change and Social Justice: An Evidence Review,* Joseph Rowntree Foundation, [Internet], Available from <www.jrf.org.uk>, [Accessed 28th May 2018]

Ramalingham B and Bound K (2016) *Innovation for International Development: Navigating the Paths and Pitfalls*, NESTA

Ramalingham B, Scriven K and Foley C (2009) *Innovations in International Humanitarian Action,* ALNAP

Rodima-Taylor D (2012) Social Innovation and Climate Adaption: Local Collective Action in Diversifying Tanzania, *Applied Geography,* Vol 33, 128-134

Rodima-Taylor D, Olwig MF & Chhetri N (2012) Adaption as Innovation, Innovation as Adaption: An Institutional Approach to Climate Change, *Applied Geography*, Vol 33, 107-111

Rotmans J, Kemp R and Van Asselt Marjolein (2001) More Evolution than Revolution: Transition Management in Public Policy, *Foresight* Vol 3, No 1, 15-31

Saith A (2006) From Universal Values to Millennium Development Goals: Lost in Translation, *Development and Change,* Vol 37, No 6, 1167-1199

Scriven K (2016) Humanitarian Innovation and the Art of the Possible, in Scriven K (Ed) Special Edition on Humanitarian Innovation, *Humanitarian Exchange*, Vol 66, 5-7

Slim H (1998) Sharing a Universal Ethics: The Principle of Humanity in War, *The International journal of Human rights*, Vol 2, No 4, 28-48

Smith A and Stirling A (2018) Innovation, Sustainability and Democracy: An Analysis of Grassroots Contributions, *Journal of Self-Governance and Management Economics*, Vol 6, No 1, 64-97

Smith A and Stirling A (2010) The Politics of Social-Ecological Resilience and Sustainable Socio-Technical Transitions. *Ecology and Society* Vol 15, No 1, 11 http://www.ecologyandsociety.org/vol15/iss1/art11/

Start (n.d) *The Start Network* [Internet], Available from: < https://startnetwork.org> [Accessed 28th May 2018]

Solecki W, Pelling M and Garschagen (2017) Transitions Between Risk Management Regimes in Cities, *Ecology and Society* Vol 22, No 2, 38 https://doi.org/10.5751/ES-09102-220238

Sorenson KK (2016) Innovating in an Ongoing Armed Conflict: The Mine Action Applications (MApps) Project in Ukraine, in Scriven K (2106) (Ed) Special Edition on Humanitarian Innovation *Humanitarian Exchange*, 66, 21-23

Strauss JA & Allen RM (2016) Benefits and Costs of earthquake early Warning, *Seismological Research Letters*, Vol 87, No 3, 765-772

Termeer C JAM, Dewulf A and Biesbroek G R (2017) Transformational Change: Governance Interventions for Climate Change Adaption from a Continuous Change Perspective*, Journal of Environmental Planning and Management,* Vol 60, No 4, 558-576

Thomalla F and Larsen R K (2010) Resilience in the Context of Tsunami Early Warning Systems and Community Disaster Preparedness in the Indian Ocean Region, *Environmental Hazards: Human and Policy Dimensions,* Vol 9, 249-265

Vandemoortele J (2011) If Not the Millennium Goals, then What? *Third World Quarterly*, Vol 32, Vol 1, 9-25

Wall I (2011) Delivering Communications in an Emergency Response: Observations from Haiti, *Humanitarian Exchange*, Vol 52, 39-41

Wise RM, Fazey I, Stafford Smith M, Park SE, Eakin HC, Archer Van Garderen ERM and Campbell B (2014) Reconceptualising Adaption to Climate Change as part of Pathways of Change and Response, *Global Environmental Change*, Vol 28, 325-336