Science–policy interface for disaster risk management in India: toward an enabling environment†

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The 2013 Uttarakhand floods highlighted the enormous challenges faced by disaster risk management organizations and actors who had to deal with it on a real-time basis. Unusual and extreme rainfalls accompanied by a series of cloudbursts triggered the flooding. In recent times there has been a significant increase in the quantum of scientific research on such weather- and climate-related extremes in some of the most vulnerable regions in India. Although the role of science and research has been adequately recognized and included in India's national development policies and programmes, including the Disaster Management Policy (2009), integration of this accumulating scientific and research evidence into disaster management policies, planning, and practices in the country has been limited. Uttarakhand floods were followed by Cyclone Phailin (2013), and the untimely hailstorms in central India (March 2014). The resulting challenges for the country and its policy makers are complex and gigantic. It is under these emerging circumstances of complexities that the urgency for proactive and effective science–policy interface is discussed. Building on the existing institutional and policy opportunities in India, an enabling environment to facilitate such science–policy interface for disaster risk management is suggested. We discuss collaboration, co-production, coherence, and continuity as some of the organizing principles of this enabling environment.

Keywords: Disaster management, enabling environment, natural hazards, science–policy interface.

INDIA is one of the most disaster-prone countries in the world. Because of its diverse bio-geographic regions and geological factors, large parts of India are at greater risk of natural hazards such as earthquakes, floods, cyclones, droughts, landslides and heat waves. The vast majority of livelihood systems and economic sectors of the country are dependent on climate. Climatic variabilities, including weather-extremes, negatively impact these systems and the people dependent on them. The recently published Working Group II Report of the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change[1] points to an increasing trend in the frequency and severity of such weather extremes and climate-induced hazards. The resulting impacts have been 'strongest and most comprehensive'. Most importantly, the level of uncertainty associated with such extreme events is high. The 2013 extreme rainfall events and the resulting floods in the Himalayan state of Uttarakhand corroborate these observations and trends. Loss and damage from this unprecedented flooding have been estimated to the tune of USD 1.91 billion and an insured loss of USD 585 million (ref. 2). This was one of the five severe natural disasters in the Asia-Pacific region in 2013.

Science in disaster risk management: recent experiences in India

Uttarakhand received around 847% excess rainfall in the week of 13–19 June 2013 and this was unprecedented; 'a record not seen for five decades'[3]. India Meteorological Department (IMD) forecast the very heavy to heavy rainfall incidents to be accompanied by severe cloudbursts. This was communicated to the disaster management authorities, both at the Central and State levels, well in advance. This body of scientific information, about the unfolding of severe weather phenomena, in one of the most disaster-prone regions of India was not sufficient enough to facilitate adequate and timely disaster preparedness and response measures to save lives and properties. What followed the Uttarakhand floods was a series

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of discussions on what went wrong and where. Much of the post-disaster analyses were focused around inadequate and imprecise weather forecasts from IMD. More importantly, such hydro-meteorological disasters are frequent in this region and the last major flash flood and landslide was in the Asi Ganga valley in August 2012. Subsequent research on this flooding event underscored the need for a disaster management policy which is based on sound understanding of the changing patterns of vulnerabilities in the region[4]. The Disaster Mitigation and Management Centre of the Government of Uttarakhand undertook a detailed investigation of the disaster incidence and submitted a report to the government in October 2012 (ref. 5). But no one is sure about the fate of that report and whether it was referred to, if at all, at any point in time. Similarly, scientific analysis of various geological and climatological factors that lead to the Kedarnath flash floods (2013) highlights the urgency to develop flash flood-forecasting models to improve disaster preparedness in the vulnerable regions of the Himalayas[6]. Research and science-based evidence on natural hazard phenomena such as landslides and flooding are adequate and ever increasing in India. But such science-based evidence and advice are often not referred to and factored in while formulating disaster preparedness measures and planning. Such contexts are aptly described as 'knowing better and even losing more'[7]. There are many factors, both proximate and underlying, for such gaps in science–policy interface in the Indian context. Srinivasan[8] identifies 'insufficient interaction between operational agencies and academic/research institutes' and 'need to improve public communication during disaster' as some of the factors. His view on the insufficient interaction is reflected in the opinion of the Vice Chairman of the National Disaster Management Authority (NDMA), the nodal agency of the Government of India for disaster management. Speaking at the South Asia Regional Consultation on Climate Change Adaptation (New Delhi, 24–27 June 2013), he stressed upon the need of information of the disaster management agencies as:

> 'They (the India Meteorological Department) need to develop a more precise observational and forecasting capability. IMD followed a standard format of weather forecast and used certain terminologies like rainfall, heavy rainfall, *but how are we supposed to translate it into action*? They need to pinpoint where and how much it is going to rain.'[9] (emphasis added)

On the other hand, the role of IMD in facilitating timely disaster response and mobilizing appropriate actions was evident during the very severe cyclonic storm *Phailin* in Odisha (October 2013). Adequate and timely cyclone forecasts from IMD and wave forecasts by the Earth System Science Organization–Indian National Centre for Ocean Information Services[10] helped the disaster management authorities, both at the Centre and the State, to efficiently coordinate the evacuation of nearly one million vulnerable and at-risk coastal communities along the Bay of Bengal in Odisha and Andhra Pradesh[11]. Successful evacuation of this scale in a disaster situation was never attempted nor accomplished before. Margareta Wahlstrom, UN Special Representative of the Secretary General for Disaster Risk Reduction, who visited Odisha in January 2014, commended the efforts of the Government and stressed upon documenting the *Phailin* response case and sharing it globally as a best practice of disaster management[12]. The then Prime Minister of India, Manmohan Singh in his address at the 101st Indian Science Congress (January 2014) in Jammu commended the role of IMD as follows:

> 'Our advances in meteorology were evident during the recent cyclone in Odisha, when we received accurate forecasts of the landfall point that were more accurate than the forecasts of well-known international bodies.'[13]

The nature of the disasters as well as the geography and political context in these two cases are quite different and cannot be compared. But the common element in these disaster situations, and for that matter in any natural disaster, is the role of science and scientific information in supporting and strengthening disaster risk management (DRM) strategies and actions. Disaster risk is an emergent process. It varies over time and space and these variations are largely influenced by interaction between natural hazards with the existing socio-economic conditions in a given society at a given point in time. Systems and assets which are more climate-sensitive and people who are poor and marginalized are at greater risk. The very recent incidence of hailstorms and untimely rainfall in central India (March 2014) completely devastated the ready-to-harvest *rabi* crops. More than 18 lakh hectare of crop was destroyed in Maharashtra alone and the crop damage has been estimated to the tune of Rs 10,000 crore (ref. 14). More importantly, increase in farmers' suicides from the hailstorm-affected regions was also reported[15].

Role of science in development planning in India

How can the contribution of science in managing such disaster risks in an emerging economy like India be enhanced and enriched? Role of science in society has been widely debated and discussed; from informing major policy decisions to shaping public discourse on critical issues such as climate change and genetically modified foods and crops. Science influences actions and choices, individual as well as collective, to various degrees. Complexities and uncertainties associated with a densely globalized and deeply inter-connected world make the role of science ever more critical. Impacts of climate change and climate-induced natural hazards have put science in the centre stage of global political discussion and economic decisions. India's contribution and leadership in science, technology and innovation has grown many fold in recent years. Science and technology is a key driver of economic growth and societal development in India. The Government of India envisages 'India as a global leader in science' and sets out a clear road map through the Vision Document (2010) prepared by the Scientific Advisory Council to the Prime Minister, one of the most powerful and influential bodies in the country. Similarly, the Planning Commission of India set up 14 Working Groups, 3 Task Forces, and 1 Steering Committee to specifically analyse various issues of and opportunities for science and technology in the country as part of the 12th Five-Year Plan (2012–17)[16]. The recent Science, Technology and Innovation Policy (2013) of India categorically emphasizes on 'value creation' through integration of science, technology and innovation and contribution to greater social good and economic wealth of the country. But the economic progress of the country and well-being of its citizens are at greater risk from natural disasters and climate-induced hazards. According to World Bank (2003) estimates[17], direct losses from natural disasters in India amount to almost 2% of its GDP and 12% of Central Government revenues annually. In the recently published Natural Hazards Risk Index[18], India is ranked fifth among the world's ten most at-risk economies to natural hazards.

Science–policy interface in India has been rapidly evolving across many sectors. The Government of India took affirmative steps towards this direction by setting up the National Knowledge Commission (2006–2009) with the overall objective 'to enable the development of a vibrant knowledge based society'. The Prime Minister's Council on Climate Change, which coordinated the National Action Plan Climate Change (2008) established, among others, the National Mission for Strategic Knowledge on Climate Change. The Ministry of Science and Technology is the nodal ministry responsible for the operationalization and implementation of this mission. The Government of India's strategic emphasis on the role of science and technology for disaster management is reflected wide and clear through the stated vision of the National Policy on Disaster Management (2009):

> 'To build a safe and disaster resilient India by developing a holistic, proactive, multi-disaster oriented and technology driven strategy through a culture of prevention, mitigation, preparedness and response.'[19]

Science–policy interface in DRM: principles of an enabling environment

Real-world operational challenges are many and various factors influence successful implementation of any such technology-driven policy strategies. Role of science and research in national development processes, and more specifically in disaster management, in India has been adequately recognized in various polices and planning documents. But there has been limited meaningful translation and operationalization of these issues in terms of evidence-informed disaster management policies and decisions in the country. Policy makers and disaster managers in India often find the existing system of disaster preparedness, response and mitigation planning completely overwhelming in the face of uncertainties in the hazard characters and the enormity and scale of disaster impacts.

It is with this realization and emerging needs of the country that we aim to highlight some of the underlying challenges in greater science–policy interface in DRM and suggest some principles to organize and strengthen such interface at various levels of planning and implementation. Our emphasis on an enabling environment is rooted in the existing institutional opportunities in the country. Such an enabling environment is proposed to revise and refine the ways research is carried out and DRM policies and actions are planned and implemented at present. Rather than reinventing the wheel, we propose some key principles, many of which are already in practice in the country, and suggest a strategic and systematic approach to science–policy interface. Four distinctive but integrated principles of collaboration, co-production, coherence and continuity are suggested to inform and shape science–policy interface at various levels. The objective is to initiate and inform discussion among the scientific, policy-making and practitioners' community to build on the existing opportunities and address the challenges across the science–policy–practice continuum in India.

We suggest the following principles to strengthen an enabling environment for science–policy interface in DRM in India.

Collaboration

Collaboration is key to build trust, acceptance and mutual respect between the scientific and the policy-making communities. Such collaboration should be multi-level and cross-scale. Collaborative research spanning across academic and scientific disciplines is essential to understand the multi-dimensional nature of vulnerabilities of a given system, community or society. Disaster risks are dynamic and differential. In order to effectively manage such disaster risks, policies and planning processes need to understand and incorporate this very dynamic nature. Scientists and researchers working on the biophysical, social, political and economic dimensions of disaster risk need to collaborate and synthesize their collective research findings in the simplest and easy-to-understand format. At present science of disaster risk is disproportionately concentrated in the assessment and analysis domains, focusing primarily on quantification of disaster risk across sectors and ecosystems. While it is essential to understand the nature of a natural hazard and quantify its impacts on all scales, the larger question that often remains grossly under-addressed is how do we translate this rich repertoire of scientific knowledge to actionable agenda. Collaboration with policy-making bodies and practitioners in setting the research agenda will enhance the chances of scientific and research evidence being adequately understood, demanded, and used by policy-makers and end-users. Many such collaborations are often limited to a specific study, commissioned by the disaster management authorities or donor agencies or research carried out through a competitive grant application which specifically emphasizes on 'policy and practice impact' of the research. Collaboration and engagement mostly happen at the fag end of a research project when research results are packaged into various formats such as policy briefs and media briefings, with a hope that these will subsequently be taken up and used. Evidence suggests that collaboration with policy-makers and end-users right from the inception phase of a research project enhances the credibility of research findings and increases their usability[20]. Strengthening collaboration among NDMA, various State Disaster Management Authorities, the Administrative Training Institutes, and the vast network of research and scientific institutes is essential. Working towards a collaborative initiative or institutional mechanism that would facilitate systematic and sustainable interface between this body of scientific knowledge with the policy-making institutions and the disaster management agencies is need of the hour. Recent proposals of a Science Research Centre (by the Uttarakhand Government) and the National Centre for Himalayan Glaciers (by the Department of Science and Technology) should provide larger institutional support for collaboration between the producers and users of science and research. Such collaboration in the past has greatly influenced and impacted the way scientific evidence is used to diffuse confusion. The response of GoI to the controversy surrounding IPCC's (2007) projections of melting and shrinking of the Himalayan glaciers is worth mentioning. The response by the Ministry of Environment and Forests (MoEF) based on the discussion paper by V. K. Raina (former Director General of the Geological Survey of India), is an example of a collaborative and constructive effort in addressing controversy and helping policy-makers and politicians base their decisions on state-of-the-art scientific evidence. This emphasis on collaboration calls for a fresh approach to disaster risk scientific research in the country and to move away from a business-as-usual culture towards a regime of user-informed, need-based, demand-driven, policy-relevant and practice-oriented research and innovation system. Secondly, such collaboration is essential to address the realized gaps in 'data sharing' among various scientific agencies and issues of 'declassifying data' to be used by researchers and the disaster management practitioners[21].

Co-production

Very often collaboration becomes an end in itself rather than being a means towards larger processes and goals of knowledge synthesis. Taking into account the unforeseen challenges and problems manifested in the 21st century society, scientists and researchers were encouraged to tackle the issues through interdisciplinary approaches of investigation; often called the Mode 2 approach to knowledge production[22]. Such co-produced knowledge is not only scientifically valid, but also socially relevant and inclusive. The ambit of such knowledge co-production systems needs to be extended further to include policy-makers and other key stakeholders, such as the local communities and the private sector. As part of this process, it is indeed critical to understand the need of the policy-makers and the intended end-users. Reconciling their needs and aspirations might not always be feasible, but in the context of disaster management it is more than essential, given the fact that their decisions and actions are critical in reducing the negative and long-lasting impacts of disasters. One key player in this co-production process is the private sector. Contribution of the private sector to India's research and development and national system of innovation is on the rise. The Joint Committee of Industry and Government (2011), set up by the Ministry of Science and Technology in its report to the ministry recommends specific measures to stimulate private sector investment in research[23]. Private sector is a leading contributor to DRM efforts and practices, and its interests and investments in this area have been substantial. In order to further promote the role of private sector in disaster risk reduction, the United Nations International Strategy for Disaster Reduction (UNISDR) has set-up a Disaster Risk Reduction Private Sector Partnership Working Group. Participation of the private sector in the co-production process in India is essential and this could be understood from the Uttarakhand disasters, where private sector investments (such as in large and medium hydro-power projects, in tourism industries and through many micro, small and medium enterprises) were the worst affected. Such co-production of disaster risk knowledge could be facilitated and monitored through a networked approach involving scientists and researchers from different institutions and backgrounds and representatives of policy-making bodies and the private sector. The Ganga River Basin Management Plan (GRBMP), established through a Memorandum of Association between the MoEF and seven IITs, is one such institutional initiative which facilitates co-production of policy-relevant and practice-oriented knowledge. The other relevant example is that of the Indian Network for Climate Change Assessment

(2009), which produced the 4 × 4 climate change assessment (2010) for India. In addition to this, country-wide research networks, Indian institutions and scientists are part of many international research collaborations spanning different disciplines and sectors. For example, scientific and research evidence on flood hazards in the Kosi River basin co-produced by research collaboration between scientists from the University of Durham (UK) and IIT Kanpur and supported by the UK–India Education and Research Initiative, has been supporting the Bihar State Disaster Management Authority[24]. Strengthening and scaling-up such knowledge co-production approaches and practices require concerted efforts of the government, research bodies, private sector, international agencies and donors.

Coherence

How do we ensure that the processes of science–policy interface and the emerging products and outputs are coherent with the larger development challenges and opportunities of the society at a given point in time? Both science and policy are power-driven processes and hence their interface would involve a lot of negotiation and reconciliation. Goals and interests of scientists and policy-makers are often divergent. Coherence is essential to address conflicts of interests and amplify synergies and co-benefits. Disaster impacts are not confined to a specific sector or section in society. This offers ample opportunity, both for the science as well as for the policy domain of DRM, to mobilize greater participation of, and contribution from, diverse sectors and departments. This requires proactive and cross-sectoral engagement among actors and institutions. Contribution and leadership of scientists and researchers are paramount in ensuring coherence, because they are better positioned to generate evidence and communicate them to diverse stakeholders and interest groups in society. More importantly, the scope of representation of scientists and researchers in policy processes should be expanded to help them better understand and appreciate policy-making. Often such representations are reduced to thematic consultations and are sporadic in nature. Developing a common framework of understanding a disaster risk context and working towards a shared vision of managing that disaster risk is absolutely important in the Indian context. Disaster risk perceptions, priorities, and views of politicians, policy-makers and scientists are diverse and often antagonistic in nature. For example, although the Disaster Management Act (2005) emphasizes on a paradigm shift from relief-centric approach towards a proactive regime of preparedness, prevention and mitigation, post-disaster politics and efforts in India are heavily oriented towards relief. A robust science–policy interface system will be instrumental in addressing the policy–practice gaps and facilitate the paradigm shift as enshrined in the Act. More importantly, it is also essential for the scientific and research community to ensure uniformity, common agreement and simplicity, when it communicates with policy-makers and the larger public. Divergent opinions and conflicting views confuse decision-making processes and in turn negatively impact the policy processes and outputs. Peter Gluckman, New Zealand's first Science Advisor to the Prime Minister encourages the scientific and research community, based on his experience of scientific evidence not being able to inform and influence health and food policy in New Zealand, to ensure sustained and effective public and policy engagement and not to always blame on 'lack of political will'[25]. One of the key barriers for effective communication and engagement between science and policy is with regard to language. Scientists and researchers produce and communicate their results in a scientific and technical language that is easily understood by their peers, but is not so easy for the policy-makers and practitioners, who look for easy-to-understand, simple and jargon-free evidence and inputs. Thus, translating such scientific knowledge into a format which is easily available, accessible and actionable is essential. Knowledge translation is a process that requires adequate understanding of the content that is produced (by scientists and researchers) and the context in which policy decisions are taken as well as their requirements. Such processes could be facilitated by trained personnel and also by organizations such as think tanks and policy-oriented research institutions in India. Secondly, participation and engagement of scientists and researchers in the implementation and evaluation of disaster management policies and measures at various levels should be facilitated. This should not be limited to one-off disaster events, but should be iterative and on-going. Joint evaluation of the disaster management actions and practices will benefit scientists and policy-makers and practitioners in terms of learning the lessons and refining future processes of engagement. This is crucial given the fact that disaster risk is a process and effective DRM is contingent upon, among others, robust institutional opportunities and incentives for social learning. Social learning facilitates knowledge sharing, joint learning and knowledge co-creation among diverse stakeholders around a shared purpose[26]. Thirdly, the policy-making community uses diverse sources of evidence. Needs for evidence vary across policy issues and are relative in nature. Very often, information and evidence required by policy-makers are either not available to them or even if available, they are not accessible in the required format. A policy community survey in South Asia undertaken by the Think Tank Initiative, a multi-donor funded programme of the International Development Research Centre, found that although environment and natural resources are issues of high policy importance, policy-makers find it difficult to access the relevant information[27]. Coherence in the science–policy interface process and approach will address some of these issues that policy-makers encounter on a day-to-day basis.

Continuity

Ensuring the continuity of collaboration and coherence across the science–policy–practice continuum for DRM is a significant challenge. Policy processes are inherently political and nonlinear in nature. Policy decisions often involve trade-offs and are achieved through layers of negotiations among various interest groups and stakeholders. Such clumsy processes might often dampen the spirit and momentum of science–policy engagement. Science and scientific bodies should enjoy their independence under such circumstances and their contribution to the policy processes should be neutral and purely based on research evidence. Ensuring continuity of the process and practice of science–policy interface is essential to build a disaster management system which is robust, adaptive and efficient. Such support and incentives for continuity have to be guided and supported through appropriate institutional and financial mechanisms at various levels. A key to this is developing the capacity of scientists and researchers to better understand and engage with DRM policy processes and practices in the country. Such processes of engagement and interface should be institutionalized and supported at the highest level. An excellent research and innovation ecosystem in India, according to Chidambaram[28], could provide the required framework for continuity and growth for science–policy interface in the country. Moreover, India is committed to some of the larger international initiatives such as the Hyogo Framework of Action (HFA) and the Yogyakarta Declaration on Disaster Risk Reduction in Asia and the Pacific (2012), both of which recognize the role of science in DRM as policy goals. Many thematic consultations on the post-2015 HFA have taken place, and some are ongoing in India. The Science and Technology Advisory Group of UNISDR recommends, among others, to promote knowledge into action and emphasizes on 'sharing and disseminating scientific information and translating it into practical methods that can readily be integrated into policies, regulations and implementation plans concerning disaster risk reduction'[29]. The recently constituted National Platform for Disaster Risk Reduction (NPDRR) of India, which had its First Session in May 2013, is one such platform which could take up specific initiative towards promoting science–policy interface on disaster risk issues in the country. The Science and Technology Division of the Planning Commission of India has taken a timely decision to support and systematically galvanize the contribution of science and technology in post-disaster reconstruction efforts in Uttarakhand[30]. It sets out a well-planned strategy and is organized into distinct phases of short, medium and long-term strategies with adequate funding allocation for various science and technology ministry/departments, earmarked specifically for 'disaster management support'. Such support, financial as well as institutional, would go a long way in ensuring continuity of efforts, energy and enthusiasm among various stakeholders, and more among the scientific and research community. The proposed initiative would engage a whole range of science and technology departments and research institutes. This will certainly provide the right institutional space and framework for establishing trans-institutional and coordinated research network. Such initiatives have been suggested as steps to build and bolster Indian science in the present age[31].

The way forward

The need for science–policy interface in DRM in India is more pronounced and prominent than ever before. Changing patterns of hydro-meteorological phenomena and their impact on the economy and society have given rise to unprecedented challenges for the disaster management mechanisms of the country. The recent forecast by IMD of a strong El Niño resulting in below-normal monsoon in India has triggered widespread concerns and speculations. The Reserve Bank of India has warned that this phenomenon could adversely impact crop yield, which in turn could further trigger the inflation rate above 8.5% (ref. 32). Appropriate risk management strategies at various levels and sectors should take into account this latest scientific and research-based evidence and initiate planning to respond to, cope with, and recover from any exigencies in the coming months in India. Such extreme weather phenomenon has become a norm rather than an exception under changing climatic conditions. It is under this emerging and uncertain disaster risk context in India that greater science–policy interface is required to enhance robust decision-making institutions to protect lives, livelihood and development gains. We hope these proposed principles will help the scientific and research community and the policy-making institutions to further refine their work, reorganize their efforts and reposition their strategies around science–policy interface in DRM and help build a disaster-resilient India.

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