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IMPROVING WATER GOVERNANCE THROUGH SCIENCE AND STAKEHOLDER DIALOGUE: EXPERIENCE FROM ASSAM (NORTHEAST INDIA)

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SUMMARY In this paper we describe some outcomes and follow-up developments of the European project BRAHMATWINN, and in particular the analyses carried out in order to identify governance gaps with respect to response strategies to deal with the expected impacts of climate change in the field of water resources management. An innovative approach based on the analysis of gaps in the governance status with specific focus on response strategies options, which can be implemented to address flood risk is implemented. A knowledge integration table (KIT) is proposed for the integration of scientific and local knowledge and this lays the foundation for the identification of the gaps between existing legal framework and real life needs. The ultimate goal of the approach is to support a process that develops recommendations for the strengthening of the governance framework in order to deal with the impacts of climate change. In a first step two parallel processes have been designed and implemented: (1) the identification of the potential supply of scientific knowledge through the development of a system of indicators proposed by BRAHMATWINN project partners, and (2) the elicitation of local actors' issues and proposed response strategies. Indicators and issues/responses are then matched in a framework, the Knowledge Integration Table (KIT), which highlights the needs basis for the research approach and integrates the outcomes of the BRAHMATWINN researchers. A Gap Analysis Matrix (GAM) is then created for the identification of gaps within the governance framework by elaborating further on the contents of the KIT: governance indicators developed within the BRAHMATWINN project are now elaborated further to measure the law and its implementation. The synthesis of this GAM should be a list of recommendations for Integrated Water Resources Management (IWRM) through the identification of potential gaps in government water resource management policy.

Contents

1. Introduction

1.1. Background

Future climate change scenarios can be modelled, but a degree of uncertainty remains. Nevertheless, a series of significant impacts on social and ecological systems are expected with a reasonable level of convergence within the international research community (IPCC, 2007a [11]). Those impacts will modify structures and functions of ecosystems and, thus, the services they provide, including modifications in hydrological regimes, water quality and quantity, thus altering for example the regulating services on floods. Ecosystem changes, in turn, will have an impact on the human dimension, i.e. on local populations, which will have to bear the consequences and try to adapt to changes in the climate and in the associated impacts. The need emerges thus to develop holistic approaches to allow for the incorporation of knowledge of different origins (scientific, empiric, historic, local) and of different perspectives to assess the potential effectiveness of adaptation measures to climate change (IPCC, 2007a [11]) in response to the expected impacts. water management is one of the sectors of greatest relevance and complexity. Consequent to this there is the need to support the development and the implementation of adaptation policies and response strategies to cope with the current and future expected impacts of climate change.

This need is also driven by the increasing public awareness of the potential impacts of global warming. Upper mountain regions of the globe, including the Himalayas, are affected by the impacts of climate change (Armstrong, 2010 [3]; Frauenfelder and Kääb, 2009 [6]) and, especially because there are uncertainties in predictions about future climate scenarios, there is the need to clarify policy objectives and set priorities. Thus, on the one hand, the collaboration between local actors and scientists seems a way to analyze local issues and propose new management options to cope with global change, meaningful for the specific case study (Walker et al., 2002 [17]). The dialogue between local actors and scientists can be enhanced through empowerment and information sharing; local actors and scientists can work together contributing to the decision making process (IPCC, 2007b [12]). On the other hand, opportunities must also be explored for bridging the gap between scientific and policy communities (IPCC, 2007c [13]).

Moreover, local actors, representing those local populations who are bearing the burden of climate change, will be the ones that will be required to implement adaption responses to changing climate, and therefore should be involved in the associated decision making process (IPCC, 2007b [12]). Local actors in the participatory process described here are stakeholders, policy and decision makers, local scientists, experts, and civil society groups. Participation of local actors anchors responses to local knowledge and needs, whilst providing a high potential for sustainability. Getting local actors involved is also one of the seven key aims of the European Water Framework Directive (WFD - Dir. 2000/06/EC [18]), and more broadly a key aspect of the concept of Integrated Water Resources Management (IWRM) (see Global Water Partnership, 2000 [9]).

There are at least two main reasons supporting inclusion of local actors' opinion in the decision making process. Firstly, public participation is needed to balance the interests of various groups. Secondly, local actors' involvement might enable greater implementation and enforcement possibilities. If local actors, in fact, are involved in decision making, transparency will be achieved by means of consultation and information processes. Also, if local actors opinions' are taken into consideration in the decision making process, and the outcome of it reflects their contribution, then they could be more willing to abide by it.

1.2. BRAHMATWINN: case study presentation

In the context of stakeholder engagement for climate change decision support the research project BRAHMATWINN[1] (www.brahmatwinn.uni-jena.de/ [21]) was funded by the EU's Sixth Framework Programme; beginning in June 2006 and ending in December 2009. BRAHMATWINN aimed at enhancing and improving capacity to carry out adaptive and harmonised IWRM approaches in headwater river systems affected by climate change. The project specifically addressed the impacts and causal relationships of climate change on hydrology, water quality and availability, land use dynamics, socio-economic processes, and legal frameworks. Research partners involved worked to understand the impact of climate change in five case study areas: two in the Upper Danube River Basin, the Lech and the Salzach River Basins (Austria and Germany); and three in the Upper Brahmaputra River Basin, Assam in India, the Wang Chu River Basin in Bhutan, and the Lhasa River Basin in Tibet Autonomous Region of China. Only one out of the five case studies will be taken into consideration in this article: the Assam State in India. This is mainly due to data availability: during the BRAHMATWINN project because of time and resources constraints not all five case studies were developed with the same level of deepness.

Climate simulations using three IPCC-SRES scenarios (A1B, A2 and B1) and the Commit scenario (i.e. the consequence of committing world economies to limit GHG concentrations at 2000 levels), five data sets (GPCC, UDEL, CRU, EAD, F&S) and four models (ERA40, CLM-ERA40, ECHAM5, ECHAM5-Γ), have been run and downscaled for the five case study areas (Dobler et al., 2011 [5]). Preliminary projections in both European and Asian regions imply a future where change will not be straightforward, but will instead exacerbate climate events already being observed, i.e. increase in the intensity of rainfall, and increase in severity of droughts during dry periods (Dobler et al., 2011 [5]). The downscaled climate scenarios were used as input to run the Danubia Model (http://www.glowa-danube.de/eng/home/home.php [22]), a coupled simulation model which is able to integrate interdisciplinary results to develop scenarios (Prasch et al., 2011 [14]). All the information produced by the BRAHMATWINN research consortium was then stored in the River Basin Information System (RBIS) and made available within the BRAHMATWINN research consortium.

Throughout this process a research need emerged in the form of finding a correspondence between local actors and research scientists to produce shared knowledge and inform both the research activities and the policy making process. Integration is a necessary goal of any project that deals with natural resources management, especially to cope with changing social-ecological systems.

Based on the outcomes of BRAHMATWINN an approach was tested to produce direct benefits for the end users: recommendations were developed keeping in mind both the specific situations of case studies, and the general global practice of IWRM and flood management.

In this paper we present the working phases that were aimed at providing a platform to allow improved communication within the research partners, and among research partners and local actors. Further research activities were carried out to capitalise, gain insights and consolidate the results of the project and derive a methodological proposals for future research. In **section 2** we describe the framework of the Knowledge Integration Table (KIT), the methodology used to define governance scores, and to perform the gap analysis. In **section 3** we describe how the gap analysis was applied in the BRAHMATWINN project

[1] For a complete overview of BRAHMATWINN's outcomes see Advances in Science & Research – Volume 7 (2011), accessible online at http://www.adv-sci-res.net/7/index.html [last access June 2011] [20]

in order to analyse responses within a governance framework. **Section 4** discusses results, and **section 5** concludes by outlining some possible recommendations.

2. METHODS

2.1. Knowledge flow and structure of the Knowledge Integration Table

Figure 1 describes the knowledge flow that led to the integration of the BRAHMATWINN research results, which are stored in the River Basin Information System (RBIS), and used for the gap analysis described in this paper.

One of the BRAHMATWINN research consortium expected outcomes was to produce knowledge addressing local actors expectations and needs. Several rounds of consultation were organized so that research partners and local actors could share their knowledge, while at the same time expressing their needs and expectations. Thus, through several workshops carried out knowledge demand and supply were identified and addressed both by BRAHMATWINN and by local actors, generating the knowledge flow represented in **Figure 1**.

A very extensive table was thus designed with the aim of improving communication between researchers and local actors, including governments and two specific objectives: (1) to provide a synoptic view of the expected intermediate products of the various disciplinary fields in terms of a catalogue of indicators and metadata; and (2) to compare and integrate the previous component with the structured outcomes of the activities carried out with local actors. Regarding the first objective, it should be remembered that the BRAHMATWINN research consortium, in fact, was made of 17 different partners, representing all the disciplinary fields needed for IWRM. Thus the need emerged to provide a table of indicators, which would list all those used or identified by each research partner. Regarding the second objective, the main need was to provide a systematic reporting of the outcomes of a series of workshops organised in the five case studies, all contributing to the analysis of local issues, expectations and preferences about the present state and future trends of the river basins water resources. Given such contents the table was called the Knowledge Integration Table (KIT).

Therefore, two processes were merged: one research driven, the other local actors driven (Ceccato et al., 2011 [4]; Giannini et al., 2011 [7]). The structure of the KIT is thus constituted of two sides. On the left hand side qualitative and quantitative indicators identified by the research partners are listed. On the right, local issues and response strategies needed or in place identified by local actors during workshops are listed. The interface between indicators and issues/response strategies takes place through a framework (Theme, Domain, Sub-Domain), which has been created specifically to facilitate this link (Ceccato et al., 2011 [4]; Giannini et al., 2011 [7]). A biunivocal relationship between the two sides is established through each Sub-Domain, which are linked to each group of indicators (left side) and to each group of issues/responses (right side). This facilitated knowledge exchange between and within project partners, on the one side, and between project partners and local actors, on the other side. Very importantly it allowed also for the identification of gaps in the information structure of the project: local issues which were not dealt with by any indicator, thus demonstrating that some relevant problems or specific aspects could not be quantitatively assessed by the project activities and, on the other side, some indicators offering the opportunity to assess issues that were not mentioned as relevant by the local actors.

The elicitation of issues and responses was carried out as one intermediate step of the implementation of the NetSyMoD approach (Giupponi et al., 2008 [8]; http://www.netsymod.eu [23]) for participatory modelling and decision support during a dedicated

workshop. Through brainstorming sessions during the Creative System Modelling (CSM) workshops, issues affecting the project case study areas were elicited from local actors involved, and existing or needed responses to cope with them were discussed, thus building shared visions and common understanding of the problems. The consolidated list of issues and responses collected during the CSM workshops carried out in Assam (April 2007), Bhutan (October 2007), Austria (October 2008), Nepal (November 2008) and Austria-Germany (February 2009) has been processed and included in the KIT. Subsequently it was also used to assess the expected effectiveness of responses to cope with flood risk under climate change impacts, by implementing the NetSyMoD phases of DSS Design and Analysis of the Options (see Ceccato et al., 2011 [4]).

Indicators were identified through a sequence of three consultations, which were carried out with project partners to populate and validate the left side of the Knowledge Integration Table (KIT). The first was carried out by distributing a template for the collection of the indicators to each partner. The following two resulted in the consolidation and validation, respectively, of the KIT by the project partners.

The two parallel processes were organized in such a way as to enable information exchange between them. Therefore, for example, the issues and responses identified by local actors can be expressed and measured through the indicators identified by project partners. As previously mentioned, a rough measure of the adequacy of knowledge produced by project partners with respect to the issues identified by local actors, derived from the extent of the match between the left (researchers') and right (local actors') sides of the KIT.

A final version of the KIT was presented at the last workshop (Kathmandu, November 2009), allowing the possibility for local actors and for researchers to give a final validation, and later on used for the governance gap analysis reported below.

2.2. BRAHMATWINN: governance scores attribution

During research carried out in beginning phases of the BRAHMATWINN project a series of qualitative governance indicators were developed by Andrew Allan and Alistair Rieu-Clarke from the University of Dundee. In this article these qualitative governance indicators have been used to assess the effectiveness with respect to the possibility of coping with flood risk, of the governance regime in place in the case study area. We will briefly recall here the methodology used to develop them as described in the deliverables written for the BRAHMATWINN project, should the reader be interested in knowing more about this research reference should be made to the following articles: Allan and Rieu-Clarke 2010; Hutton et al. 2011; and Rieu-Clarke et al. 2010.

These indicators of effective governance took into consideration the fact that implementation of the law rarely matches the letter of the legislation, and therefore evaluated both the content of the relevant law (UNDP, 2004 [16]), and the degree to which it appeared to be applied in reality (Allan and Rieu-Clarke, 2010 [1]). The indicators assessed factors beyond those that related simply to water, taking the view that as the broader governance framework would have a significant impact on whether or not water resource management was effective, wider issues of transparency, accountability, participation and predictability should be measured (Hutton et al., 2011 [10]). In this context, predictability was used as a proxy for IWRM, so the assessment exercise in fact included a detailed analysis of the governance and management framework in place for water resource management. For each qualitative indicator, a model answer was developed, following the methodology used by the World Bank in its Country Policy and Institutional Assessment (CPIA) process (World Bank, 2005 [19]), and broadly reflecting what might be considered as international best practice in each case.

The resulting series of fifteen broad indicators (see Rieu-Clarke et al., 2008 [15]) have thus been acquired and are listed in **Table 1**, which is coherent with the framework presented in **section 2.1** above. The qualitative indicators were then applied to the case study areas to highlight the strengths and weaknesses of each governance framework and to identify areas of concern – for example where there were wide disparities between what the law said and the reality of its implementation, or where the law in place was inadequate when compared with what might be expected by international best practice. Scores were allocated for each of the many sub-questions, assessed against the model answers for each indicator, and these were combined to produce composite scores out of 100 for each of the four principal areas (i.e. transparency, accountability, participation and predictability).

For each of these principal areas therefore, composite scores were derived to indicate firstly the state of the law as it is written, and secondly, the extent to which it appears to be implemented. **Table 1** also highlights the relation that was made between these governance indicators and those suggestions from stakeholders at the CSM workshops that indicated what they believed the priority responses should be. The bridge between them consists of the Sub-domain column. As will become clear in the Gap Analysis, no equivalence is suggested between the expert-derived qualitative indicators and the stakeholder responses, merely a relation, albeit a resonant one in many cases.

2.3. Gap analysis

The information stored in the KIT led to the creation of the Gap Analysis Matrix (GAM). According to the methodologies described in **section 2.1**, the relevant elements were taken from the KIT to create the GAM (see **Figure 2**): governance indicators defined by project partners and response strategies identified by local actors were taken to create the GAM. In effect the Gap Analysis Matrix turns the KIT around, so that instead of trying to match local actors' views with those of the project partners, the GAM takes as its starting point those responses identified by local actors in the Assamese workshop (April 2007).

The rows of the gap analysis matrix are aligned with the responses that were elicited from local actors in CSM workshops. The columns take and develop the scores set out in **Table 1**. Since, as discussed below, a direct import of these scores was not possible, because of the absence of an equivalence between the responses and the indicators, each indicator was attributed to one or more response as shown in **Table 2**. The elaboration of this framework allows the reader to see the extent to which the governance framework actually corresponds with what stakeholders believe is necessary. Governance indicators are used to assess the gaps in the governance, and this enables measurement of how far governance has defined an effective response. A gap is identified when there is the absence of an effective governance response corresponding with the need identified by the local actors. This might take the form of the lack of an effective and relevant provision in law, poor institutional coordination, or no government commitment in the form of an appropriate policy statement that post-dates the last relevant legislation. Ultimately, scores have been attributed by authors interpreting and elaborating local actors opinions expressed during CSM workshops to test the GAM.

An initial effort had to be made to determine which of the governance indicators were most relevant with respect to each response, because the stakeholder responses upon which the table is based do not align perfectly with the various governance indicators. This happens because two research streams carried out independently were merged. For example, with respect to the response "Community involvement in decision-making", this has relevance to the following governance indicators:

- Rights of stakeholders established and maintained, including civil society

organisations, and disadvantages or underrepresented groups to participate in decision-making;
- Consultation of citizens actively sought by government institutions on policy issues, budgetary priorities and development decision;
- Effective participation of all stakeholders, including civil society organisations, in water and flood management;
- Civil society access to redress and remedy.

The scores for each of these indicators were then calculated averaging the relevant indicators. These average figures were then entered into the governance columns of the GAM. This was repeated for each of the responses until the table was fully populated.

3. Results

By comparing the responses identified by local actors with the governance assessment outlined in **paragraph 2.2** above, it is possible to assess governance needs with respect to the vulnerability to flood risk. The result of the gap analysis, in fact, from the governance perspective was to highlight those policy areas where gaps are found between what local actors expressed during the workshop, i.e. response strategies needed, and the governance situation as it currently stands. The GAM (see **Table 3**) outlines the combined scores from the governance assessment in **paragraph 2.2** above, through the filter of the responses identified by local actors in the CSM workshops.

It is clear that the bulk of the responses identified by local actors have been valued in the governance assessment as being potentially problematic in Assam. Thus, in general, we can say that strengthening and improvement of responses, or of their implementation, is needed. That stakeholders should be raising questions with regard to community participation, however, in spite of the fact that many rights, obligations and powers already exist in law hints at problems with lack of awareness, or lack of faith in the system's capacity to provide access to redress or remedy, issues that have both been recognized in the lower implementation scores (Allan and Rieu-Clarke, 2008 [2]).

The exercise underlines a number of key deficiencies in relation to the other governance element, the water management context in Assam, both in terms of the quality of the policy context and also in relation to the issues that are neglected at the institutional, legal and policy levels. **Table 3** also suggests, however, that awareness of the risks of floods and water resource management among other issues, has actually been tackled well. As a caveat to this, however, it is essential to note that direct comparison between the broad questions asked in the governance assessment and the responses highlighted by stakeholders is difficult, and the scores above give no impression as to the efforts that are ongoing to address particular areas of concern. By way of example, "policy making and implementation of laws" in **Table 3** looks to be relatively successful both with respect to legal commitment and to implementation. Given the breadth of this issue, though, and the fact that the vast majority of the other issues raised suffer from significant gaps between commitment and implementation, one might expect the policy environment to take heed of the potentially significant problem of implementation. The evidence from the eleventh Five Year Plan and from the priorities of the Indian Law Society for example does not appear to back this up unfortunately (Allan and Rieu-Clarke, 2008 [2]). It is also interesting to note the disparity between the extent to which IWRM is in place in law, and awareness of the risks of flood and water resource management issues. The fact that awareness does appear to be so high raises questions as to why the water management system remains so poorly rated and why comprehensive legislative reaction has been so slow. Finally, Assam was given low scores in terms of coordination –

firstly, between relevant management institutions, and secondly between the riparian Union and Nation states on the Brahmaputra river. This concern has a direct relation with the degree to which IWRM is perceived to be in place: the question of whether India should tackle institutional coordination first before enacting IWRM-led legislation, or vice versa must be addressed as a matter of urgency.

4. Discussion

Ranking the results according to the scores we can look at the responses who have the worst scores, i.e. the responses which, according to our definition, to have the highest gap with respect to design of law and implementation. These are (from the bottom):

1. IWRM
2. Establishment of institutions
3. Protection of communities
4. Relief and rehabilitation
5. Coordination among institutions

As we can see from **Table 2** all but one (i.e. "establishment of institutions") have been calculated averaging two or three governance indicators. Some interesting insights have been found looking at the single indicators which compose them (see **Figure 3**). For three responses, namely (a) "protection of communities", (b) "relief and rehabilitation", and (c) "coordination among institutions" one of the two indicators used has quite high values, if compared to the values of the other indicators. The bad performance is due to, respectively, the following governance indicators:

a) (9) All relevant risks are taken account of and mitigated in flood planning
b) (11) Flood risk taken into account in broader land / water use management and environmental impact assessment
c) (8) Clear rights and obligations in relation to IWRM and Climate Change
(11) Flood risk taken into account in broader land / water use management and environmental impact assessment

While the fourth, "IWRM", is the result of the average of three governance indicators with poor values:

- (7) Water management conducted in accordance with IWRM
- (8) Clear rights and obligations in relation to IWRM and Climate Change
- (9) All relevant risks are taken account of and mitigated in flood planning

One can see how these indicators reflect, in fact, a generally poor performance of all indicators relative to flood management. Looking at the single governance indicators relative to the Sub-domain "IWRM-NRM" (**Table 1**) this comes as no surprise since this is the Sub-domain with the lowest values. One could therefore conclude that policy sectors which need strengthening are those related directly to flood risk management. However, it must also be noticed, that the governance indicator "(10) Effective emergency alleviation and response system that limits risk and protects people, property and environment", also related to the Sub-domain "IWRM-NRM" features quite well, when compared to all the other governance indicators, being the eighth value in "law" and the tenth in "implementation" (out of fifteen). Thus, possibly, emergency response issues in Assam are not a priority with respect to existence of law, on the other hand more should be done with respect to implementation.

Moreover the governance indicator "(15) Checks and balances between different branches of government" as all other governance indicators relative to the Sub-domain "general institutional and legislative frameworks" features very well: third in "law" and first in "implementation". The Sub-domain "general institutional and legislative frameworks" is, in fact, the one with the governance indicators that have the highest values (**Table 1**). So little improvement is requested on this issue.

5. Conclusions

The research carried out was aimed at understanding how the information collected and elaborated during the research could be used to identify governance gaps in water and flood management, and thus provide recommendations for improvement in the IWRM governance framework. The BRAHMATWINN research project provided insights relative to the three pillars of sustainability, i.e. environment, society, economy, and in addition of governance, which are listed in the Knowledge Integration Table (KIT) and matched to local actors' issues and responses. Selected information from the KIT was used to create a Gap Analysis Matrix (GAM), where responses to address flood risk identified by local actors were evaluated against governance indicators extracted from the KIT. This shows that the exercise described in this article is based on previous research, therefore it is constrained by outcomes of previous phases of BRAHMATWINN.

It must be said, however, that the KIT must not be thought of a rigid and definitive table, but more of a flexible structure within which indicators can be added or modified according to research needs and new findings. Ultimately, the crucial feature of the KIT is that it can be a useful tool for the integration of the research results coming from the range of different disciplines represented, combined with the views of local actors.

The creation of the KIT constitutes an approach contributing to the implementation of knowledge integration, which many acknowledge as necessary, by creating a relationship between research outcomes (qualitative and quantitative indicators) and local actors issues and responses. Thanks to the GAM policy recommendations have been identified. These include improving the level of institutional coordination for the management of water resources, whether in dry or super-abundant periods, the establishment of a legal basis for the comprehensive management of water resources, and a recognition at government level that serious effort, both in planning and policy, is required if Assam is to address current and future availability and potential conflict between the various sectoral user groups. While it is making progress in some key areas (notably in relation to early warning systems), there does seem to be a worryingly low level of effective community participation in decision making.

It has to be noticed that the framework presented in **Figure 1** is in fact an iterative cycle. The outcome of the process described in this article, i.e. the definition of recommendations, is presented to local actors and, thus, fed back into the cycle. Whether these recommendations could lead to a decrease in vulnerability could be monitored using the relevant indicators identified in the KIT (see Giannini et al., 2011 [7]). The cycle would in this way be closed, showing one possible method to bridge the gap between science and policy and cope with impacts of climate change.

Ultimately, this exercise and the proposed methods could be further refined in future studies bearing in mind that the KIT should be developed during the initial phases of the projects and iterative refinements should be allowed for. This would enable, on the one hand, that the researchers could totally address the knowledge demand voiced by local actors, on the other, that local actors have enough time and opportunities to completely integrate local knowledge in the process. In the BRAHMATWINN research, due to time constraints, there was limited possibility to have the partners rearranging their research agenda to totally meet issues expressed by local actors, and also to acquire all the relevant information from local actors.

One example of further research that would be needed as a follow up to this exercise is integrating vulnerability indicators into this process. Linking vulnerability indicators or indices in the GAM to governance indicators and response strategies, one could assess the effect of governance measures on

vulnerability, by means of future projections of values based on scenarios, or one could also prioritize governance measures to be developed and implemented according to a vulnerability ranking.

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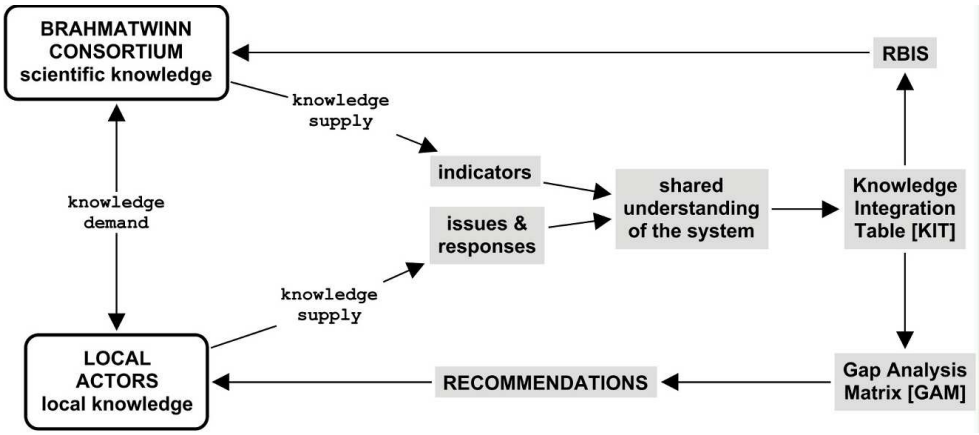

Figure 1 Knowledge flows within the BRAHMATWINN Project.

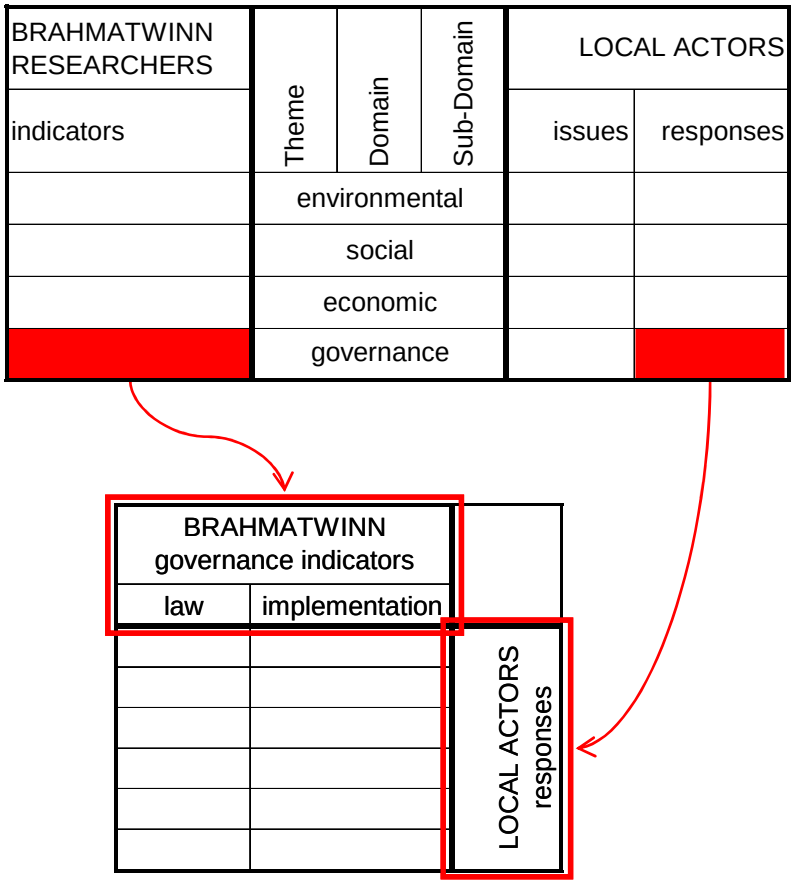

Figure 2 Scheme for the creation of the Gap Analysis Matrix (GAM) and development of recommendations. Top: KIT; bottom: GAM.

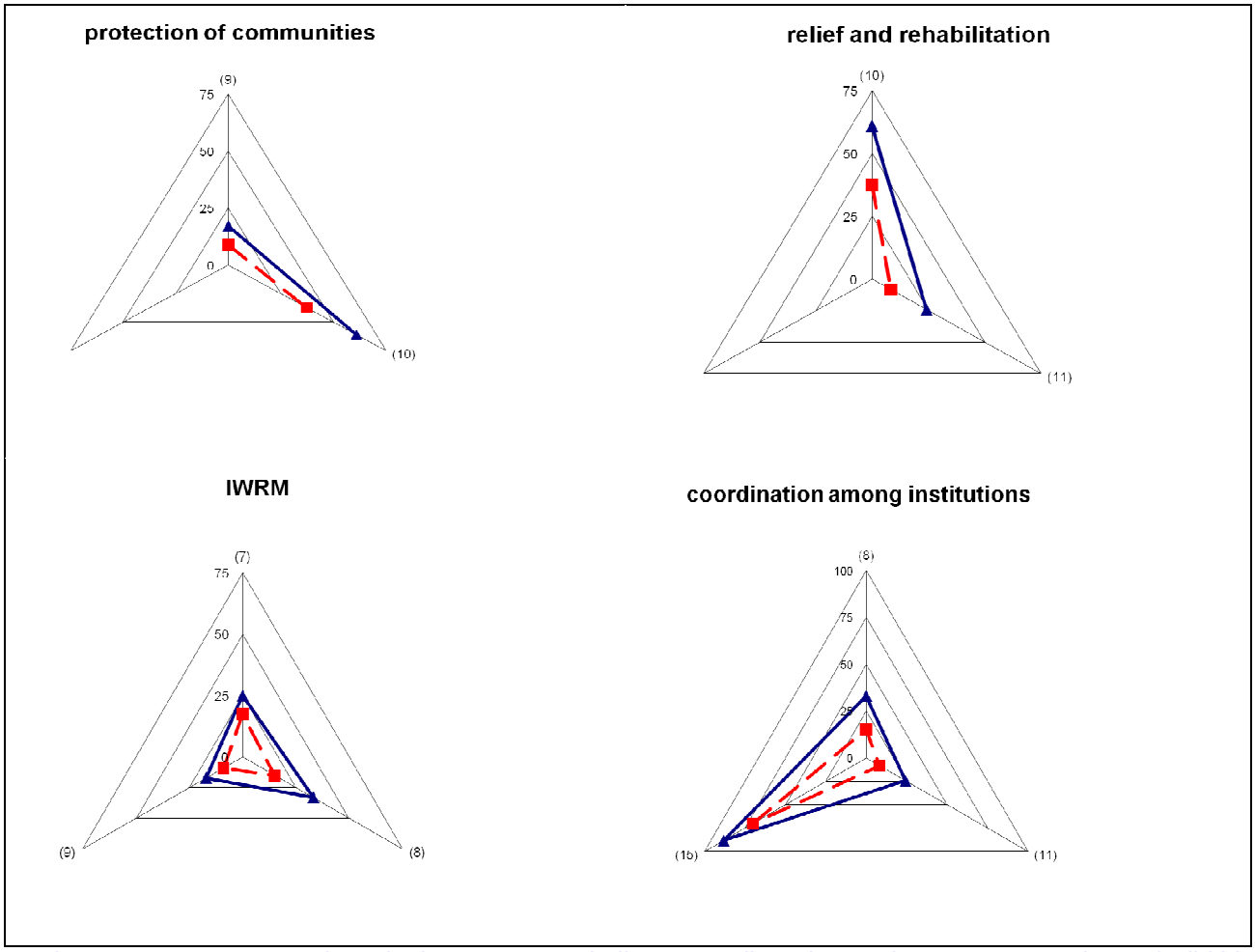

Figure 3 Responses scoring: single governance indicators attributed to each response are shown (solid blue lines and triangles: law; dashed red lines and squares: implementation).

Table 1 Governance indicators and scores with associated responses as elicited during the BRAHMATWINN workshops, extracted from the KIT, includes responses from all case studies of BRAHMATWINN.

Theme	Domain	BRAHMATWINN RESEARCHERS			Sub-Domain	LOCAL ACTORS
		indicators	Score [%]			responses
			law	imple-mentation		
GOVERNANCE	Education	(1) Availability of environmental information to the public where requested, including actual copies of the documentation containing or comprising such information.	84	60	Increase knowledge	Integration and coordination among different sectors of research and decision making; Increase awareness and knowledge on best practices and research on impacts of natural hazards; Environmental monitoring; Flood modelling; Dissemination of knowledge; Educational policy.
		(2) Clear and coherent roles and responsibilities for the effective collection and generation of information related to IWRM and Climate Change.	52	68		
		(3) Clear and coherent roles and responsibilities for the effective exchange of data and information relevant to IWRM and Climate Change.	49	40		
	Institutional and legislative frameworks	(4) Rights of stakeholders established and maintained, including civil society organisations, and disadvantaged or underrepresented groups to participate in decision-making	77	43	Public Participation	Improve community involvement and foster participatory processes for decision-making, policy-making and implementation of laws; Foster livelihood practices as long-term practices, based on conservation, rehabilitation and sustainability.
		(5) Consultation of citizens actively sought by government institutions on policy issues, budgetary priorities and development decisions	80	63		
		(6) Effective participation of all stakeholders, including civil society organisations, in water and flood management	43	20		
		(7) Water management conducted in accordance with IWRM	25	18	IWRM /NRM	Establishment of institutions; Resolve conflicts and strengthen coordination among institutions; Protection of communities; Early Warning systems; River training works; Multi-purpose dam construction; Control of GLOFs; Channel improvement; Agricultural practices; Relief and rehabilitation.
		(8) Clear rights and obligations in relation to IWRM and Climate Change	33	15		
		(9) All relevant risks are taken account of and mitigated in flood planning	17	9		
		(10) Effective emergency alleviation and response system that limits risk and protects people, property and environment?	61	38		
		(11) Flood risk taken into account in broader land / water use management and environmental impact assessment	24	8		
		(12) Enforceable and adequate rights of access to information (including environmental information)	97	70	General institutional and legislative frameworks	Accountability and transparency in government actions; Implement and enforce existing laws and design new and more effective laws; Inter-state coordination and conflict resolution, cross-boundary issues.
		(13) Civil society access to redress and remedy	94	49		
		(14) System to challenge a law on the basis that it violates international law or the constitution	88	70		
		(15) Checks and balances between different branches of government	88	70		

Table 2 Attribution of BRAHMATWINN researchers' governance indicators to local actors' responses for the definition of the scores: an X marks the link, i.e. which indicator is used to assess each response with respect to the governance frameworks, Assam State only (see **Table 1** for legend of indicators).

BRAHMATWINN RESEARCHERS: governance indicators																
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)		
			X	X	X							X			Community involvement in decision making	LOCAL ACTORS: responses
									X						Early Warning System	
								X	X						Protection of communities	
									X	X					Relief and rehabilitation	
						X	X	X							IWRM	
X	X			X	X							X			Awareness of the population on risks, conservation, and WRM	
						X									Establishment of institutions	
			X	X											Policy making and implementation of laws	
							X			X				X	Coordination among institutions	
			X	X	X	X				X	X				Long-term vision and measure VS. short-term engineering solutions	
		X				X							X		Inter-state conflict, cross boundary issues	

Table 3 Gap analysis matrix: average scores of governance indicators.

BRAHAMATWINN RESEARCHERS: governance indicators			
law [%]	implementation [%]		
73	**44**	Community involvement in decision making	LOCAL ACTORS: responses
61	**38**	Early Warning System	
39	**23**	Protection of communities	
43	**23**	Relief and rehabilitation	
25	**14**	IWRM	
70	**52**	Awareness of the population on risks, conservation, and WRM	
25	**18**	Establishment of institutions	
78	**53**	Policy making and implementation of laws	
48	**31**	Coordination among institutions	
58	**37**	Long-term vision and measure VS. short-term engineering solutions	
54	**43**	Inter-state conflict, cross boundary issues	