ZEF

Working Paper Series

56

Center for Development Research

Department of Political and Cultural Change

universitätbonn

Zentrum für Entwicklungsforschung
Center for Development Research

ISSN 1864-6638

Bonn 2010

Saravanan V.S. and Peter P. Mollinga

Water Pollution and Human Health

Transdisciplinary Research on Risk Governance in a Complex Society

ZEF Working Paper Series, ISSN 1864-6638
Department of Political and Cultural Change
Center for Development Research, University of Bonn
Editors: H.-D. Evers, Solvay Gerke, Peter P. Mollinga, Conrad Schetter

Authors' addresses

Dr. Saravanan V.S.
Center for Development Research (ZEF), University of Bonn,
Walter-Flex-Str. 3
53113 Bonn, Germany
Tel. 0049 (0)228-73 4918: Fax 0228-731972
E-mail: s.saravanan@uni-bonn.de
www.zef.de

PD Dr. Peter P. Mollinga
Center for Development Research (ZEF), University of Bonn,
Walter-Flex-Str. 3
53113 Bonn, Germany
Tel. 0049 (0)228-73 4918: Fax 0228-731972
E-mail: pmollinga@uni-bonn.de
www.zef.de

Water Pollution and Human Health

Transdisciplinary Research on Risk Governance in a Complex Society

Saravanan V.S. and Peter P. Mollinga

Abstract

Increasing population, geological factors, rapid urbanisation, agricultural developments, global markets, industrial development and poor wastewater regulation have affected the quantity and the quality of water. These activities have not only exhausted existing water resources, but also have triggered contamination of water by naturally occurring toxic minerals (fluoride, nitrate and arsenic), and have caused chemical pollution affecting human health and the environment. Water pollution is intricately linked with a number of sub-systems of urbanisation, agricultural activity, food security, and human health, making it a complex system responding to stimuli in various sub-systems. Complexity, non-linearity and interactions across multiple scales are compounded by the interplay of social, political and technological processes.

ZEF's research programme on 'water and health' aims to examine the complex ways in which local and global forces influence water pollution and human health through a comprehensive and integrated perspective. 'Comprehensive' and 'integrated' approaches represent a sequential combination, in which comprehensive assessment helps to understand the openness of the system and the diversity of actors and components that interact within the system, while an integrative perspective helps in understanding how the interaction of the key components exhibits self-organisation capacity, making the system a complex adaptive system. This approach helps to consciously design rules, and at the same time, build capacity of human entities to design rules, to manage risk posed by water pollutants. This is vital for prevention of diseases, for human well-being, and, more importantly, for alleviation of poverty.

The presented research framework identifies four phases of risk governance. The first two phases – risk assessment and risk impact, generate and collect information on risk, while the latter two phases – risk strategies and risk adaptation, offer insights on the decision-making strategies to risk mitigation. The risk governance framework proposes transdisciplinary research on human health by engaging with non-academic stakeholders in the research design and dissemination of the research findings. The research seeks to make substantial and innovative contributions in the field of global change and human health research.

Keywords:
water pollution, human health, complexity, risk, governance

1 Introduction

Sustainable use of water resources has come under increasing stress in recent decades. Globally, the availability of water per person has declined markedly (MEA, 2005) with over a billion people lacking access to safe water supplies and 2.6 billion people lacking adequate sanitation. Most basic needs and livelihood activities depend on the availability of fresh water. With its availability becoming scarcer, water is becoming critical to meet the basic needs and support livelihood requirements for environmental management and for alleviation of poverty. Increasing population, geological factors, rapid urbanisation, agricultural developments, global markets, industrial development and poor wastewater regulation have affected the quantity and the quality of water. These activities have not only exhausted existing water resources, but have also triggered contamination of water by naturally occurring toxic minerals (fluoride, nitrate and arsenic), and have caused chemical pollution affecting human health and the environment.

This 'water pollution and health' scenario is further complicated by the rapid evolution of water-related pathogens as they interact with socio-ecology. The evolutionary 'trial and error' approach of pathogens not only defeats the most carefully thought out human defence strategies, but also gives rise to new human pathogens. This is known as zoonosis: non-human viruses cross the species barrier (Woolhouse, 2002). The emergence and re-emergence of pathogens illustrates the intimate intertwining of disease dynamics with socio-political, economic, ecological and demographic change (Bloom et al., 2007). This confronts contemporary stable institutions and standard health interventions. Complexity, non-linearity and interactions across multiple scales are compounded by the interplay of social, political and technological processes. Understanding the complex ways in which local and global forces influence water pollution and human health is a challenge. These complex linkages are the focus of ZEF's 'water pollution and human health' research. Understanding the complexity is vital for prevention of diseases, for human well-being, and, more importantly, for alleviation of poverty.

ZEF's research on water pollution and health aims at designing policies and strategies to develop efficient public health care schemes to improve human health for sustainable development (ZEF, 2007:20). It has four objectives:

1. understand the linkage between global environmental change and public health;
2. build the capacity of the public sector institutions to address the growing challenge from global environmental change;
3. build capacity as a centre of excellence for transdisciplinary public health research and be in the forefront of public health research;
4. build capacity of regional institutions in public health research to advocate policy change in their respective countries.

ZEF research will focus on the entire population ranging from local neighbourhood to as big as an entire country, where it attempts to protect and improve health through a comprehensive approach - this in contrast to clinical professionals primarily treating individuals after they become sick or injured. This 'public health' perspective will help to improve the health and well-being of people in local communities and across nations, with special focus on vulnerable and marginal sections of the population. (http://www.whatispublichealth.org/what/index.html accessed 15 September 2007).

2 Water Pollution in a Complex Society — A Conceptual Framework

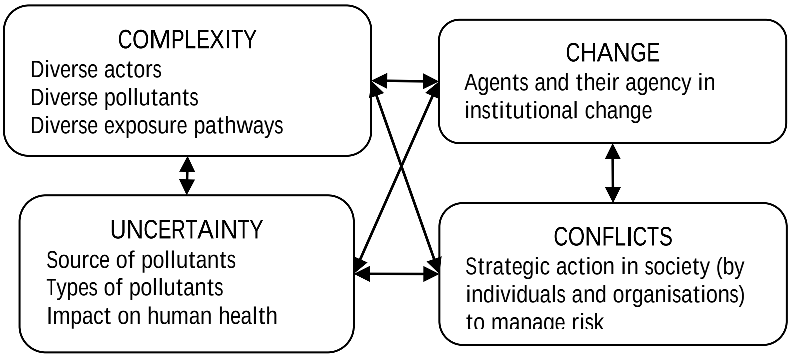
Water pollution can be defined as the excessive presence of chemical, physical or biological substances (pollutants) in water due to human activities with a harmful effect on humans and their environment. These pollutants take various forms. The broad classes of pollution are the following.

1. Water transmitted diseases from pathogens: diseases transmitted by microbial viruses, bacteria, and other parasites through water; bacteria, viruses, protozoa and parasitic worms that enter sewage systems and/or thrive on fresh water.
2. Pollution from domestic wastewater: domestic wastewater from residential regions demands oxygen-requiring bacteria to degrade the waste into organic compounds; when there is excess wastewater it depletes the oxygen level in the water causing other organisms in the water, such as fish, vegetation and other microbes to die.
3. Chemical pollution: from agriculture, use of fossil fuel (in transport systems) and industrial activities discharging acids, oil, pesticides, salts and toxic metals; large quantities of these compounds will make water unfit to drink and will cause the death of human and aquatic life; water-soluble nitrates and phosphates (from agricultural fertiliser) can cause excessive growth of algae and other water plants, which deplete the water's oxygen supply and can kills fish; when found in drinking water these substances can kill young children.
4. Geogenic pollution: Excess fluoride, arsenic and nitrate in drinking water and water used for domestic purpose have caused serious public health problems in South Asia and Latin America (Kundzewicz, et al, 2007; Magrin et al., 2007). There are a number of contradictory accounts on the origin, exposure to and its dimension on the socio-cultural and institutional impact. Research should be directed towards understanding their contamination route to water sources, different forms of their exposures on humans and in developing adaptive response from the existing institutional arrangements.

Water pollution has emerged as a major public health concern as a result of man-made and environmental changes at local and global scales. These developments are a multi-layered process, questioning the existence of a linear relationship between pollutants and their human impact. McMichael sums up this point by emphasising (in his conversation with Shetty, 2006:21) that most of the contemporary attempts at controlling water pollution related health problems are "attuned to simple high-school models of science, with clear-cut cause-effect relationships, most of us are yet to grasp the risks to human societies and health from these escalating changes to the world's complex non-linear systems, whether climate system or ecosystems". Water pollution is intricately linked with a number of sub-systems of urbanisation, agricultural activity, food security, and human health, making it a complex system responding to stimuli in various sub-systems (McMicheal, 2001: Label, 2003).

There are two basic interpretations for unravelling the systems perspective. The first takes a comprehensive view that a broad array of variables and their interrelationships should be examined (this draws on Emory Roe (1998) and the collection of papers in Ecology and Society, volume 4, number 2). The second takes an integrative view by suggesting that the complexity of living systems of people and nature emerges, not from a random association of a large number of interacting factors, but rather from a smaller number of controlling processes (Holling, 2001). These processes establish a persistent template upon which a host of other variables exercise their influence. Such 'subsidiary' variables or factors can be interesting, relevant, and important, but they exist at the whim of the critical controlling factors or variables (Holling, 2001). These 'comprehensive' and 'integrated' approaches do not represent alternative views, but may be thought to represent a sequential combination: comprehensive assessment helps to understand the openness of the system and the diversity of actors and components that interact within the system, while an integrative perspective helps in understanding how the interaction of the key components that exhibits self-organisation capacity, making the system a complex adaptive system (Railsback, 2001; Mitchell, 2005).

Figure 1.Water pollution and health as a complex adaptive system



Note: The system is influenced by local and global forces at any point of time, thus leading to punctuation in the system.

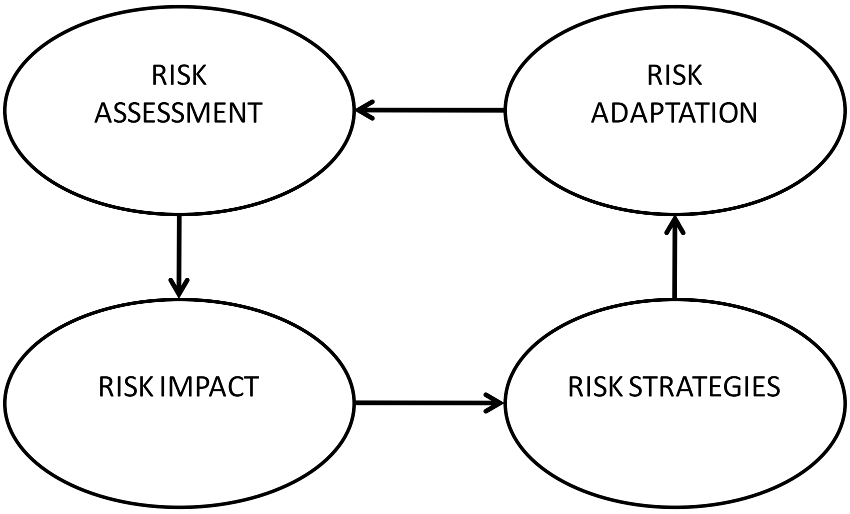
The complex adaptive system consists of four inter-related properties characterising its structure dynamics – complexity, uncertainty, conflicts and change (Mitchell, 1997) (see figure 1). The diversity of actors discharging diverse pollutants affects human health through multiple pathways, making for ontological complexity of the system. This interacts with demographic, socio-cultural, economic, and other regional factors that have differential impact on human individuals and their environment, and which are not completely understood. Often this results in considerable uncertainty in which decisions have to be taken. With incomplete and imperfect understanding, human entities (individuals and organisations) develop strategic action, often resulting in competing claims and demands over water pollution. These conflicts are facilitated (or constrained) by socially or institutionally distinct agents, who attempt to change (policies and programmes) the existing institutional arrangements and bio-physical environment (through technology or other means). These changes are not always perfect or efficient, but the system has the capacity to self-organise, leading to back to complexity. The interaction among these properties is not cyclic in the sense of the system returning back to or revolving around a certain state in response to water pollution and health events. It is cyclic in the sense of emergent - the complex ebb and flow of the events through multi-scale interactions with unexpected behaviour generates 'structural elaboration' (Archer 1995), that is, the system is characterised by self-organisation and adaptiveness.

The fact that we live in a society of complex adaptive systems, means we live in a 'risk society' (Beck, 1992). The concept of 'risk society' does not want to imply that the world is more hazardous than linear, closed system perspectives suggest. Rather, it recognises a "modern approach to foresee and control the future consequences of human actions" (Giddens, 1999:3-4) by adapting to risks rather than assuming they can be eliminated or fully controlled. The aim of ZEF's research on water pollution and health is to understand the risk posed by water pollutants on human health and the environment. This will help in governing risk to sustain livelihoods of the deprived sections of the population in the urban and peri-urban zones, in the context of growing urbanisation, industrialisation and increasing population.

3 Risk Governance in a Complex Society

The World Health Report (2002) argues that focusing on risks to health is the key to prevention, as much of the scientific effort and most health resources today are directed towards treating disease. With roots in environmental risk assessment, research on health risk has gained prominence in recent decades to comprehensively understand the ability of a society to take risk in a responsible way. Risk governance aims to consciously design rules, and at the same time build capacity of human entities to design rules to manage risk posed by water pollutants in order to sustain the livelihood of people, in the context of growing challenges from local and global environmental change. This requires a comprehensive understanding of risk posed by water pollutants on human health by identifying the pathways of risk assessment, understanding the impacts of the water pollutants, and analysing the diverse set of strategies adopted by human entities involved in bringing change in the existing institutions and bio-physical resources. The research framework identifies four phases of risk governance research[1] (see figure 2).

Figure 2. Phases of risk governance research



The first two phases – risk assessment and risk impact – generate and collect information on risk, while the latter two phases – risk strategies and risk adaptation – offer insights on the decision-making strategies for risk mitigation.

Understanding the integrated nature of risk governance in water and health requires moving beyond an interdisciplinary mode of research towards transdisciplinary research on human health. A transdisciplinary approach goes beyond disciplinary boundaries by engaging with non-academic stakeholders (Mollinga, 2008). The approach is appropriate as it provides a comprehensive perspective and involves stakeholders in the research design and dissemination of the research findings. Transdisciplinary approach integrates different forms of knowledge existing at various levels, not limited to expert opinion (Ramadier, 2004). However, the approach offers number of challenges for the research community. Pohl (2005) and Antrop and Rogge (2006) encountered unclear and shifting objectives of the research team, lack of common language, and more importantly, pressure to produce less practically usable but more academically prestigious results.

A transdisciplinary perspective is important for defining the incidence of diseases, understanding the diverse perspectives (not only scientific understanding) and to understand how the system interacts through a number of pathways influencing water and health (Mollinga, 2008). ZEF's research will adopt diverse research methods depending on the context and apply different modelling software (for example GIS-based and Bayesian network approaches) for understanding the complex linkages between water pollution and human health.

3.1 Risk Assessment – Complexity of Pathways

The analysis of risk assessment involves the documenting of material exposure and analysing the social risk perception of individuals and organisation. The first examines the exposure pathways that individuals and society face in the event of the water pollution. What are the different forms of exposure that individuals and society experience, and how? The second examines the perception pathways of the individuals and societies to the risk posed by these pollutants. What are the different perceptions of individuals and society in view of the pollutants in their environment? How have these evolved?

Understanding exposure is a key element in the ability of a society to assess the risk posed by water pollutants. Exposure is defined as "the contact at one or more boundaries (e.g. mouth and skin) between

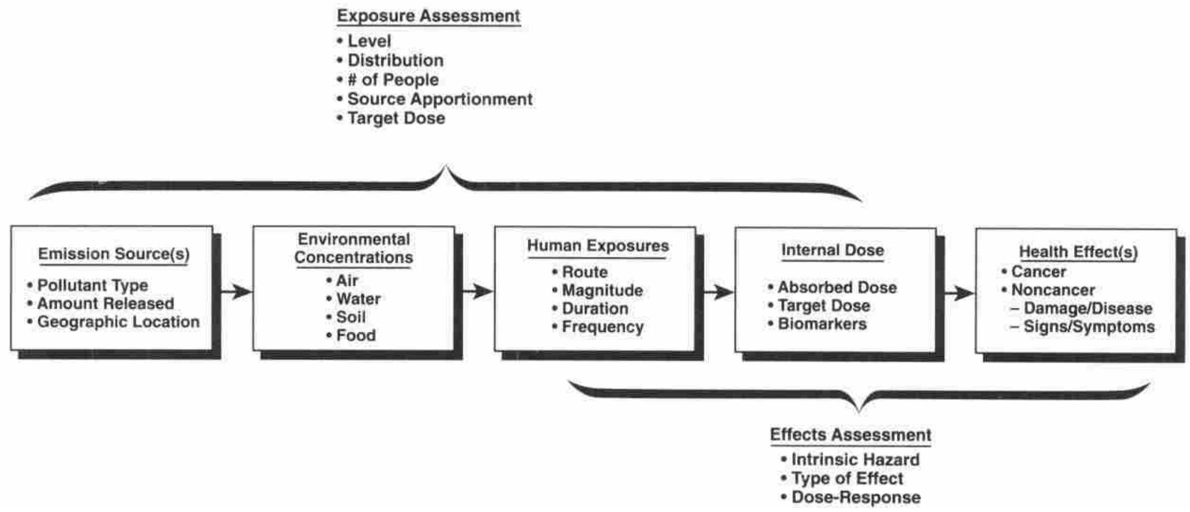
[1] In recent years, the International Risk Governance Council (IRGC, 2005; 2007) has developed a risk governance framework drawing from the sociological perspective for understanding of risk (see Renn, 2008 for details).

human and a contaminant(s) at a specific concentration(s) for a period of time" (Lioy, 1990). The exposure pathway starts from release of pollutants into the environment, to a concentration of the pollutants in one or more environmental media, to actual human exposure, to internal or delivered dose, and ultimately to environmentally induced disease and injury (Sexton, et al., 1992). Exposure has four aspects:

1. Route – do exposures occur by inhalation, ingestion, dermal contacts and injection or a combination of these?
2. Magnitude – what is the pollutant concentration (e.g., parts per million, micrograms per cubic meter, milligrams per litre)?
3. Duration- what is the duration of exposures- minutes, hours, days, and lifetimes?
4. Frequency – how often do exposures occur – daily, weekly, monthly or seasonal?

Briggs (2003) argues that there is no single source of pollutants causing exposure to health effects; we are exposed to multiple mixes of pollutants, often derived from different sources, some of which may have additive or synergistic effects. Further, these forms of exposures are related to human behaviour, and social, cultural, demographic and economic factors. The myriad ways in which these factors influence and interact with environmental conditions, exposures, human susceptibility and health outcome, questions the effect of environment per se. It is this combination of material risk and the socio-cultural dimensions that contribute to risk assessment. Sexton et al. (1992) conceptualise a series of events (figure 3) that helps our understanding on the material risk associated with water pollution. Evaluating the health risks associated with pollutants is composed of two primary activities: (1) exposure assessment, and (2) effects assessment.

Figure 3. Relationship of exposure assessment and effects assessment



Source: Sexton et al., 1992:399

Exposure assessment evaluates the initial portion of the event chain, while the health effects assessment focuses on the final portion of the event sequence, i.e., exposure, dose and adverse effects. The goals of the latter evaluation will be twofold: a) determine the intrinsic health hazards associated with the pollutant; and b) quantification of the relationship between exposure and health effects in human populations. Understanding or establishing the link between pollution sources, human exposures and adverse health effects will provide insights for establishing governance arrangements to protect against harmful consequences of pollution (Sexton et al., 1992). The conceptual framework of emission source to health effects informs the passage of pollutants towards health impacts, and offers a framework to map the effect of human behaviours, and social, cultural, demographic and economic factors that influence risk perception.

Pathways of social perception are based on the exposure to the events and the ability of the society (individual and groups of individual) to amplify or attenuate a risk. It is not a simplistic process. Kasperson et al. (1988) argue in their social amplification of risk framework (SARF) that it is a dynamic process. In this process certain hazards and events that experts assess as relatively low in risk can be amplified, while others that experts judge as most serious get less attention from society (they are attenuated) The amplification of risk occurs at two stages: a) in the transfer of information about the risk, and b) in the response mechanisms of the society. Amplification denotes the phenomenon by which information processes, institutional structures, social group behaviour, and individual responses shape the social experiences of risk, thereby contributing to risk consequences. The interaction reveals that the information systems and characteristics of public response that compose social amplification are essential elements in determining the nature and magnitude of risk. The starting point of the social amplification of risk framework (SARF) is that 'risk events' which might include actual or hypothesized accidents and incidents will be largely irrelevant or localized in their impacts unless human beings observe and communicate them to others. The key part of this communication holds that risk and risk events and the characteristics of both become portrayed through various risk signals (images, signs, and symbols). These risk signals interact with individual and social amplification stations, which in turn affect institutional and social behaviour, creating ripple effects in the society and its subsequent impacts (Kasperson et al., 2003). The framework demonstrates the importance of the social construct to acquire or create interpretations of risks.

This SARF framework has a number of areas that require improvement in order to make it relevant for public policy. First, the framework represent a simplistic one-way transfer of information – from risk events, and sources, through transmitters and then on to receivers. Pidgeon et al. (1992) argue that social risk perception is an interactive process. Second, Breakwell and Barnett (2003) observe that social amplification and attenuation processes are complex dynamic social phenomena. They suggest a 'layering' method as an integrative and multidimensional technique for collecting data and identifying relevant relationships. Third, the framework has focused more on the views of individuals, rather than on organisations that are responsible for managing risk, and on the larger societal context. Fourth, the framework is suitable for general analysis rather than specific analysis of particular (water pollution and health) events. Fifth, the framework does not itself address many of the process underlying the risk communication. Sixth, risk is not only a result of the social construct, but also is a material construct, and it is the interaction between these that constitutes risk. Finally, the framework could be amended to offer insight in understanding the process behind individual and societal amplification (and attenuation) of risk. Social perceptions are intertwined combinations of the attitudes of individuals (socio-cultural and economic factors) and behaviour of the existing institutions (media, public and private organisations). Understanding these complex sets of factors will offer insights on the role of existing governance arrangements and social and cultural factors in shaping perception of risk posed by water pollution.

3.2 Risk Impact – Understanding Uncertainties

Different exposures and risk perceptions contribute to differential impact on human health (individually and communally, over space and time). The complexity of exposures and assessments contributes to a situation in which decisions have to be taken in the face of considerable uncertainty due to incomplete and imperfect understanding of the impact. Assessing the impacts requires placing health at the centre-stage to identify risks for different sections of the society that are measurable, risks that we know but are not measurable, risks that we are ignorant about, and risks that we cannot determine. Health impact assessment (HIA) has emerged as a discipline developing decision-support tools to predict the future consequences of implementing different activities and policies on health (Kemm, 2005). The most widely quoted definition of HIA is "a combination of procedures, methods and tools by which a policy, programme or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population" (ECHP, 1999:4). This approach primarily views health impact as a result of the causal influence of policies, programmes or projects, but rarely reflects McMichael's (2001) 'health as an integrated index'.

Health is an integrated index of social, physical, institutional and political factors. Human health is not only an individual entity influenced by biological functioning of the human body, the presence of genes, humans' nutritional status, and their life history, but also is a collective property of a population (McMichael, 2001), where the circumstances, experiences and dynamics of the groups and populations plays an equally important role. In addition to this individual and collective property aspect, human health is also influenced by the evolution of pathogens, which increases the resistance capacity of infectious diseases leading to their emergence and re-emergence. This makes the linkage between water pollution and human health a complex and contingent process (Briggs, 2003). The complex linkage between water pollution and human health is highly interdependent, non-linear, and context specific. This calls for a more complex and dynamic perspective on human-disease-ecological systems, in contrast to the simplistic linear pathways of impact assessments. However, this offers two major challenges for the public research community. First, they need to go beyond their professional boundaries and paradigms, and second, move beyond examining local and global to a more integrated global-local interface (McMichael, 2006). Assessing the impact of water pollution on human entities and their environment will help in identifying measurable risks, uncertain risks (that we know will affect humans but are uncertain), risks that we are ignorant about and, risks that we cannot determine at all. This will help in influencing medical and institutional decisions in the face of considerable uncertainty, as it is not realistic to wait until analysts develop the depth of understanding that we would like to have before committing ourselves to a path of action.

3.3 Risk Strategies

The differential risks for human health and the environment often leads to differential strategic actions to overcome competing claims and demands over water resources. These actions range from citizen control through consensus to non-participation, and may lead to conflicts (Arnstein, 1969). These strategic actions have rationality of their own and analysing them is important to understand the causes or factors behind the action. How do responses depend on how individuals and society perceive uncertainties about water pollution? How do risk-related cognitions and emotions influence uncertainties, and what roles do socio-demographic and contextual factors, risk judgement and information exposures play in this differential action and why?

Griffin et al. (1999) developed the risk information seeking and processing (RISP) model. The model integrates the heuristic-systematic processing model and the theory of planned behaviour to examine how people differentially react to risk information. The RISP model postulates that the gap between what people know and what they perceive they need to know (information sufficiency) will influence information processing (i.e., heuristic or systematic) and information seeking (i.e., active, routine, avoidance) behaviours. In turn, information sufficiency is predicted by affective responses to a risk and beliefs about what others think they should know about the risk. Bennett (1999) reveals that trust, fright factors, values, risk comparisons and understanding the probability of risks have an important bearing on actions. Langford et al. (1999) draw on cultural theory to analyse strategic actions depending on understanding of the health risk. Though these models offer explanatory power, they have a limited use to structure or restructure existing institutions and their functions to govern risk.

3.4 Risk Adaptation

The strategic action of individuals and society are carried and promoted by socially or institutionally distinct agents (Strydom, 2008) to adapt to the inadequacy of existing resources and institutional arrangements. These agents, who mutually recognise the risk, embody different risk perception and risk management strategies in accordance with distinct modes of engagement with the world. These agents make sense of and act upon a risk in multi-levelled network in and through which incoming information about a given risk reality is processed in a socially distributed way (Strydom, 2008). Occupying different positions yet parallel to one another, each of the participating agents frames and communicates the mutually recognised risk in their own way. Thereby agents activate resonance structures which allow responses in the form of feedback of one kind or another as well as connections to be forged. In doing so, each of them contribute to the way in which the risk becomes collectively classified, understood and dealt with.

Social theorists like Giddens and Archer have provided significant insights towards understanding agents and their emergence. Agents for Giddens (1984:xxii) are individuals, who have as “an inherent aspect of what they do, the capacity to understand what they do while they do it”. They possess ‘transformative capacity' (1984:15), which is another way of saying they possess power. The transformative capacity emerges as a result of routinization, a basic element of day-to-day social activity and fundamental concept of structuration theory, where structural properties (rules and resources) are constantly recreated out of these resources (Giddens, 1984:xxiii). Archer (2003:118) recognises agents as individuals, but argues that there are "collectivities sharing the same life-chances' (emphasis as in original). Following Giddens (1984) she recognises the role of structures, as agents are born within them and inherit their agency from them (Archer, 2000:262, cited in Llewellyn, 2007). These agents 'are people with a project' (Sayer, 1992:119; Archer, 2003:2-3, cited in Llewellyn, 2007:134), pursuing a common goal. Prospects to understand the adaptive management of risks in practice, requires examining agents and their agency. Facilitating the adaptive management practice of agents if combined with the institutional analysis approach of Ostrom (1990) will help in identifying institutions and their differential role in facilitating (or constraining) change for a sustainable future.

Examining risk in a comprehensive manner, as risk assessment, risk impacts, risk strategies and risk adaptation will offer insights for comprehensive intervention strategies. Assessing risk will examine past practices, global and local actors, and socio-ecological changes that have led to the complexity of water pollutants and their impact on human health. Impact analysis will enhance understanding of different forms of uncertainty due to water pollutants and their impact, the vulnerable social groups affected by water pollution and lacunae in development programmes in addressing water pollution. Analysing risk strategies will enhance interventions to build capacity of organisations and individuals in overcoming health impact. Adaptiveness to risk will enhance interventions to facilitate (or constrain) change for a sustainable future of public health. Overall this will enhance the capacity of public agencies to design rules and build capacity of actors to adapt and integrate rule s for governing risk for sustainable public health. Some of the key issues and themes for research on public health that are useful to advance further are given in table 1.

Table 1. Themes for research

RESEARCH PHASE	RESEARCH ISSUES	RESEARCH THEMES
RISK ASSESSMENT	Material Risk • Source of pollutants (activities) • Causes of pollutants (social institutional and ecological) • Process involved in its contamination, and their inter-linkages. • Forms of exposures (human and environmental) Social Risk • Factors driving different forms of exposures. • Factors contributing to different risk perceptions and their inter-linkages.	• BIOMES AND HUMAN ACTIVITIES • EXPOSURE MAPPING • RISK PERCEPTION ANALYSIS • PROBLEM ANALYSIS
RISK IMPACT	• Impact of exposures on human health. • Differential impact of pollutants on human and environment. • Policies and programmes contributing to these differences. • Socio-cultural, demographic and Institutional factors facilitating (or constraining) the impact.	• EPIDEMIOLOGY OF HUMAN HEALTH • HEALTH IMPACT ANALYSIS
RISK STRATEGIES	• Existence of different strategies to address pollution. Organisational strategies Technical strategies Socio-cultural strategies • Legislation, economics and socio-cultural factors facilitating strategies.	• CAPABILITY ANALYSIS
RISK ADAPTIVENESS	Agents and agency involved in adaptive management. Socio-economic, cultural and Institutional factors facilitating or constraining them.	• ADAPTIVE CAPACITY • AGENCY

Gaining knowledge on the different phases of risk governance will enhance the capacity to govern risk posed by water pollution, to alleviate poverty and at the same time to add to effective resource management. A comprehensive analysis of risk governance should offer insights for necessary changes in the prevailing governance arrangements for the modern state to be effective in delivering development and security (Fritz and Menocal, 2007:532). In specific, it will offer insights for enhancing the developmental role of the state for consciously designing rules, and at the same time, facilitate building capacity of organisations to design rules for managing risk. This embraces the state as a network of authoritative institutions that makes and enforces top-level decisions throughout a territorially defined political entity (Chesterman et al, 2005).

4 Towards a Research Programme

ZEF's research on water pollution and health plans to comprehensively investigate the risks posed by water pollution to human health in five broad research areas, coinciding with five broad factors contributing to water pollution, in low-resource countries.

1. Adaptive Responses to Water-borne and Vector-borne Diseases: Research to develop adaptive responses through epidemiological studies to understand the relationship between human behaviour and health outcomes, applying GIS-based risk mapping and multi-agent modelling to project water-borne and vector-borne diseases, institutional analysis and means to facilitate adaptive response.
2. Urbanisation, Agriculture and Human Health - Examining the Complexity of Linkages: Wastewater irrigation has been practiced in many countries around the world, especially in growing economies, placing its growing population in urban and peri-urban region at risk. Research to examine the inter-linkages among these diverse sets of factors to: gain insights for sound legal and regulatory frameworks, offer in-depth understanding of the factors that drive farmers to (re)use wastewater, provide directions for effective public health protection and maintenance of environmental quality.
3. Globalisation and Human Health: Industries, especially small-scale industries are emerging as one of the major consumers of water resources, combined with poor urban and regional planning to dispose large quantities of chemically polluted wastewater. Research to analyse the global forces and their interaction with local and regional factors impacting on human health, central for the development of adaptive management strategies for industrial pollution.
4. Adaptive Responses to Geogenic Pollution: Excess fluoride, arsenic and nitrate in drinking water and water used for domestic purposes have caused serious public health problems in South Asia and Latin America. There are a number of contradictory accounts on the origin, exposure to and the socio-cultural and institutional impact dimension. Research to be directed towards understanding the contamination route to water sources, different forms of exposures on humans and towards developing adaptive responses from the existing institutional arrangements.
5. Global Environmental Change and Human Health: One of the most evident and adverse effects of global environmental change has been the development of waterlogging and salinity on agricultural land of the Indo-Gangetic Plains (India-Bangladesh). The research will examine the linkages between human and natural causes of land degradation and the impact of saline drinking water sources on human health.

References

Archer, M. 2003. Structure, agency and the internal conversation. Cambridge: Cambridge University Press.

Arnstein, Sherry R. 1969. A Ladder of Citizen Participation. Journal of American Planning Association 35(4): 216-224.

Barnett, J. and Breakwell, G. 2003. The Social Amplification of Risk and the Hazard Sequence: The October 1995 OC Pill Scare. Health, Risk and Society 5 (3) : 301-313.

Beck, U. 1992. Risk society: Towards a new modernity. New Delhi: Sage Publications.

Bennett, P. 1999. Understanding Responses to Risk: Some Basic Findings. In P. Bennett and K. Calman (Eds.) Risk communication and public health. Oxford: Oxford University Press.

Bloom, G., J. Edstrom, M. Leach, H. Lucas, H.MacGregor, H. Standing, and L. Waldman. 2007. Health in a dynamic world. STEPS Working Paper 5. Brighton: STEPS Centre.

Bogner, J., M. Abdelrafie Ahmed, C. Daiz, A. Faaji, Q. Gao, S. Hashimoto, K. Mareckova, R. Pipatti, and T. Zhang. 2007. Waste Management. In M.L. Parry, O.F. Canziani, J.P. Palutikof, L. Van der Linden and C.E. Hanson (Eds.) Climate change 2007: Impacts, adaptation and vulnerability. Contribution of working group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press, pp. 585-616.

Briggs, D. 2003. Making a difference: Indicators to improve children's environmental health. Geneva: World Health Organisation.

Chestermann, S., M. Ignatieff, and R. Thakur. 2005. Making states work: State failure and the crisis of governance. Tokyo: United Nations University Press.

Confaloneri, Ulisses and Anthony McMichael. 2007. Science plan and implementation strategy: ESSP joint project on GEC and human health – contribution of IHDP Task Force. Bonn: International Human Dimensions Programme (IHDP).

Confalonieri, U., B. Menne, Akhtar, K.L. Ebi, M. Hauengue, R.S. Kovats, B. Revich and A. Woodward, 2007. Human Health. In M.L. Parry, O.F. Canziani, J.P. Palutikof, L. Van der Linden and C.E. Hanson (Eds.) Climate change 2007: Impacts, adaptation and vulnerability. Contribution of working group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press, pp. 391-431.

Cruz, R.V., H. Harasawa, Lal, S. Wu, Y. Anokhin, B. Punsalmaa, Y. Honda, M. Jafar, M.C. Li, and H. Huu Ninh. 2007. Asia. In M.L. Parry, O.F. Canziani, J.P. Palutikof, L. Van der Linden and C.E. Hanson (Eds.) Climate change 2007: Impacts, adaptation and vulnerability. Contribution of working group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press, pp. 469-506.

ECHP (European Centre for Health Policy). 1999. Gothenburg consensus paper. WHO Regional Office for Europe.

Fritz, V. and A.R. Menocal. 2007. Developmental States in the New Millennium: Concepts and Challenges for a New Aid Agenda. Development Policy Review 25(5): 531-552.

Giddens, A. 1984. The constitution of society. Cambridge: Polity Press.

Giddens, A. 1999. Risk and Responsibility. Modern Law Review 62(1): 1-10.

Griffin, R.J., S. Dunwoody, and K. Neuwirth. 1999. Proposed Model of the Relationship of Risk Information Seeking and Processing to the Development of Preventive Behaviours. Environmental Research 80: S230-S245.

GWSP (Global Water System Project). 2005. The global water system project: Science framework and implementation activities. Bonn: Earth System Science Partnership.

Holling, C.S. 2001. Understanding the Complexity of Economic, Ecological, and Social Systems. Ecosystems 4: 390-405.

Huntington, T.G. 2006. Evidence from Intensification of the Global Water Cycle: Review and Synthesis. Journal of Hydrology 319: 83-95.

IRGC (International Risk Governance Council). 2005. White paper on risk governance: Towards an integrated approach. White Paper No.1 by O. Renn. Geneva: IRGC.

IRGC International Risk Governance Council). 2007. An introduction to the IRGC risk governance framework. Policy Brief. Geneva: IRGC.

Kasperson, E.R., O. Renn, P. Slovic, H.S. Brown, J. Emel, R. Goble, X.J. Kasperson, and S. Ratick. 1988. The Social Amplification of Risk: A Conceptual Framework. Risk Analysis 8: 177-187.

Kasperson, J.X., R.E. Kasperson, N. Pidgeon, and P. Slovic. 2003. The Social Amplification of Risk: Assessing Fifteen Years of Research and Theory. In N. Pidgeon, R. Kasperson, and P. Slovic (Eds.) The social amplification of risk. London: Cambridge University Press, pp. 13-46.

Kemm, J. 2005. The Future Challenges of HIA. Environmental Impact Assessment Review 25: 799-807.

Kundzewicz, Z.W., L.J. Mata, N.W. Arnell, P. Doll, P. Kabat, B. Jimenez, K.A. Miller, T. Oki, Z. Zsen, and I.A. Shiklomanov. 2007. Freshwater Resources and Their Management. In M.L. Parry, O.F. Canziani, J.P. Palutikof, L. Van der Linden and C.E. Hanson (Eds.) Climate change 2007: Impacts, adaptation and vulnerability. Contribution of working group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press, pp. 173-210.

Lebel, J. 2003. Health: An ecosystem approach. Canada: IDRC.

Langford, H.I., C. Marris, and T. O'Riordan. 1999. Public Reactions to Risk: Social Structures, Images of Science, and the Role of Trust. In P. Bennett and K. Calman (Eds.) Risk communication and public health. Oxford: Oxford University Press.

Lioy, J.P. 1990. Assessing Total Human Exposure to Contaminants. Environmental Science and Technology 24: 938-945.

Llewellyn, S. 2007. Introducing the Agents.... Organization Studies 28: 133-153.

McMichael, J.A. 2001. Human frontiers, environments and disease: Past patterns, uncertain futures. Cambridge: Cambridge University Press.

McMichael, A. 2006. Population Health as the 'Bottom-line' of Sustainability: A Contemporary Challenge for Public Health Researchers. European Journal of Public Health 16: 579-582.

McMichael, J.A., E.R. Woodruff, and S. Hales. 2006. Climate Change and Human Health: Present and Future Risks. The Lancet 367: 859-869.

MEA (Millennium Ecosystem Assessment). 2005. Ecosystems and human well-being: Desertification synthesis. A Report of the Millennium Ecosystem Assessment. Washington DC: World Resources Institute.

Mitchell, B. 1997. Resource and environmental management. London: Longman Publications.

Mitchell, B. 2005. Integrated Water Resource Management, Institutional Arrangements and Land-use Planning. Environment and Planning A 37: 1335-1352.

Mollinga, P.P. 2008. Discussion note on transdisciplinary research for ZEF's water pollution and health initiative in India. Manuscript for Centre for Development Research (Zentrum für Entwicklungsforschung). Bonn: ZEF.

Railsback, S.F. 2001. Concepts from Complex Adaptive Systems as a Framework for Individual-based Modeling. Ecological Modeling 139: 47-62.

Renn, O. 2008. Risk governance: Coping with uncertainty in a complex world. London: Earthscan.

Roe, E. 1998. Taking complexity seriously: Policy analysis, triangulation and sustainable development. Boston MA: Kluwer Academic,.

Saravanan, V.S and P.P. Mollinga. 2008. Water pollution and its implication on human health: An agenda for research. Unpublished manuscript. Bonn: ZEF.

Sayer, A. 1992. Method in social science: A realist approach. London and New York: Routledge.

Sexton, K., S.G. Selevan, K.D. Wagener, and A.J. Lybarger. 1992. Estimating Human Exposures to Environmental Pollutants: Availability and Utility of Existing Databases. Archives of Environmental Health 47: 398-407.

Shetty, P. 2006. Tony McMichael: A Visionary of the Environment-health Interface. The Lancet 368(9529): 21.

Strydom, P. 2008. Risk Communication: World Creation through Collective Leanring under Complex Contingent Conditions. Journal of Risk Research 11: 5-22.

WHO (World Health Organisation). 2002. The world health report 2002: Reducing risks, promoting healthy life. Geneva: World Health Organisation.

Woolhouse, M.E.J. 2002. Population Biology of Emerging and Re-emerging Pathogens. Trends in Microbiology, 10(10): 3-7.

ZEF (Zentrum für Entwicklungsforschung). 2007. A Strategy for the future of ZEF: The next decade 2007-2017. Bonn: Center for Development Research (Zentrum für Entwicklungsforschung), University of Bonn.

Acknowledgements

An earlier draft of this paper was presented at the Senate Committee on Water Research of the German Research Foundation (DFG) on 10th October 2008; IHDP Open Meeting 26-30th April 2009, and at the Workshop on Human Health and Environment at the Department of Geography, University of Bonn. The comments received from these gatherings are gratefully acknowledged. The usual disclaimers apply.

ZEF Working Paper Series, ISSN 1864-6638
Department of Political and Cultural Change
Center for Development Research, University of Bonn
Editors: H.-D. Evers, Solvay Gerke, Conrad Schetter

1 Evers, Hans-Dieter and Solvay Gerke (2005). Closing the Digital Divide: Southeast Asia's Path Towards a Knowledge Society.
2 Bhuiyan, Shajahan and Hans-Dieter Evers (2005). Social Capital and Sustainable Development: Theories and Concepts.
3 Schetter, Conrad (2005). Ethnicity and the Political Reconstruction of Afghanistan.
4 Kassahun, Samson (2005). Social Capital and Community Efficacy. In Poor Localities of Addis Ababa Ethiopia.
5 Fuest, Veronika (2005). Policies, Practices and Outcomes of Demand-oriented Community Water Supply in Ghana: The National Community Water and Sanitation Programme 1994 – 2004.
6 Menkhoff, Thomas and Hans-Dieter Evers (2005). Strategic Groups in a Knowledge Society: Knowledge Elites as Drivers of Biotechnology Development in Singapore.
7 Mollinga, Peter P. (2005). The Water Resources Policy Process in India: Centralisation, Polarisation and New Demands on Governance.
8 Evers, Hans-Dieter (2005). Wissen ist Macht: Experten als Strategische Gruppe.
8a Evers, Hans-Dieter and Solvay Gerke (2005). Knowledge is Power: Experts as Strategic Group.
9 Fuest, Veronika (2005). Partnerschaft, Patronage oder Paternalismus? Eine empirische Analyse der Praxis universitärer Forschungskooperation mit Entwicklungsländern.
10 Laube, Wolfram (2005). Promise and Perils of Water Reform: Perspectives from Northern Ghana.
11 Mollinga, Peter P. (2004). Sleeping with the Enemy: Dichotomies and Polarisation in Indian Policy Debates on the Environmental and Social Effects of Irrigation.
12 Wall, Caleb (2006). Knowledge for Development: Local and External Knowledge in Development Research.
13 Laube, Wolfram and Eva Youkhana (2006). Cultural, Socio-Economic and Political Con-straints for Virtual Water Trade: Perspectives from the Volta Basin, West Africa.
14 Hornidge, Anna-Katharina (2006). Singapore: The Knowledge-Hub in the Straits of Malacca.
15 Evers, Hans-Dieter and Caleb Wall (2006). Knowledge Loss: Managing Local Knowledge in Rural Uzbekistan.
16 Youkhana, Eva, Lautze, J. and B. Barry (2006). Changing Interfaces in Volta Basin Water Management: Customary, National and Transboundary.
17 Evers, Hans-Dieter and Solvay Gerke (2006). The Strategic Importance of the Straits of Malacca for World Trade and Regional Development.
18 Hornidge, Anna-Katharina (2006). Defining Knowledge in Germany and Singapore: Do the Country-Specific Definitions of Knowledge Converge?
19 Mollinga, Peter M. (2007). Water Policy – Water Politics: Social Engineering and Strategic Action in Water Sector Reform.
20 Evers, Hans-Dieter and Anna-Katharina Hornidge (2007). Knowledge Hubs Along the Straits of Malacca.
21 Sultana, Nayeem (2007). Trans-National Identities, Modes of Networking and Integration in a Multi-Cultural Society. A Study of Migrant Bangladeshis in Peninsular Malaysia.
22 Yalcin, Resul and Peter M. Mollinga (2007). Institutional Transformation in Uzbekistan's Agricultural and Water Resources Administration: The Creation of a New Bureaucracy.
23 Menkhoff, T., Loh, P. H. M., Chua, S. B., Evers, H.-D. and Chay Yue Wah (2007). Riau Vegetables for Singapore Consumers: A Collaborative Knowledge-Transfer Project Across the Straits of Malacca.
24 Evers, Hans-Dieter and Solvay Gerke (2007). Social and Cultural Dimensions of Market Expansion.
25 Obeng, G. Y., Evers, H.-D., Akuffo, F. O., Braimah, I. and A. Brew-Hammond (2007). Solar PV Rural Electrification and Energy-Poverty Assessment in Ghana: A Principal Component Analysis.
26 Eguavoen, Irit; E. Youkhana (2008). Small Towns Face Big Challenge. The Management of Piped Systems after the Water Sector Reform in Ghana.
27 Evers, Hans-Dieter (2008). Knowledge Hubs and Knowledge Clusters: Designing a Knowledge Architecture for Development
28 Ampomah, Ben Y., Adjei, B. and E. Youkhana (2008). The Transboundary Water Resources Management Regime of the Volta Basin.
29 Saravanan.V.S.; McDonald, Geoffrey T. and Peter P. Mollinga (2008). Critical Review of Integrated Water Resources Management: Moving Beyond Polarised Discourse.
30 Laube, Wolfram; Awo, Martha and Benjamin Schraven (2008). Erratic Rains and Erratic Markets: Environmental change, economic globalisation and the expansion of shallow groundwater irrigation in West Africa.
31 Mollinga, Peter P. (2008). For a Political Sociology of Water Resources Management.
32 Hauck, Jennifer; Youkhana, Eva (2008). Histories of water and fisheries management in Northern Ghana.
33 Mollinga, Peter P. (2008). The Rational Organisation of Dissent. Boundary concepts, boundary objects and boundary settings in the interdisciplinary study of natural resources management.
34 Evers, Hans-Dieter; Gerke, Solvay (2009). Strategic Group Analysis.
35 Evers, Hans-Dieter; Benedikter, Simon (2009). Strategic Group Formation in the Mekong Delta - The Development of a Modern Hydraulic Society.
36 Obeng, George Yaw; Evers, Hans-Dieter (2009). Solar PV Rural Electrification and Energy-Poverty: A Review and Conceptual Framework With Reference to Ghana.
37 Scholtes, Fabian (2009). Analysing and explaining power in a capability perspective.
38 Eguavoen, Irit (2009). The Acquisition of Water Storage Facilities in the Abay River Basin, Ethiopia.
39 Hornidge, Anna-Katharina; Mehmood Ul Hassan; Mollinga, Peter P. (2009). 'Follow the Innovation' – A joint experimentation and learning approach to transdisciplinary innovation research.
40 Scholtes, Fabian (2009). How does moral knowledge matter in development practice, and how can it be researched?
41 Laube, Wolfram (2009). Creative Bureaucracy: Balancing power in irrigation administration in northern Ghana.
42 Laube, Wolfram (2009). Changing the Course of History? Implementing water reforms in Ghana and South Africa.

43 Scholtes, Fabian (2009). Status quo and prospects of smallholders in the Brazilian sugarcane and ethanol sector: Lessons for development and poverty reduction.
44 Evers, Hans-Dieter, Genschick, Sven, Schraven, Benjamin (2009). Constructing Epistemic Landscapes: Methods of GIS-Based Mapping.
45 Saravanan V.S. (2009). Integration of Policies in Framing Water Management Problem: Analysing Policy Processes using a Bayesian Network.
46 Saravanan V.S. (2009). Dancing to the Tune of Democracy: Agents Negotiating Power to Decentralise Water Management.
47 Huu, Pham Cong, Rhlers, Eckart, Saravanan, V. Subramanian (2009). Dyke System Planing: Theory and Practice in Can Tho City, Vietnam.
48 Evers, Hans-Dieter, Bauer, Tatjana (2009). Emerging Epistemic Landscapes: Knowledge Clusters in Ho Chi Minh City and the Mekong Delta.
49 Reis, Nadine; Mollinga, Peter P. (2009). Microcredit for Rural Water Supply and Sanitation in the Mekong Delta. Policy implementation between the needs for clean water and 'beautiful latrines'.
50 Gerke, Solvay; Ehlert, Judith (2009). Local Knowledge as Strategic Resource: Fishery in the Seasonal Floodplains of the Mekong Delta, Vietnam
51 Schraven, Benjamin; Eguavoen, Irit; Manske, Günther (2009). Doctoral degrees for capacity development: Results from a survey among African BiGS-DR alumni.
52 Nguyen, Loan (2010). Legal Framework of the Water Sector in Vietnam.
53 Nguyen, Loan (2010). Problems of Law Enforcement in Vietnam. The Case of Wastewater Management in Can Tho City.
54 Oberkircher, Lisa et al. (2010). Rethinking Water Management in Khorezm, Uzbekistan. Concepts and Recommendations.
55 Waibel, Gabi (2010). State Management in Transition: Understanding Water Resources Management in Vietnam.
56 Saravanan V.S., Mollinga, Peter P. (2010). Water Pollution and Human Health. Transdisciplinary Research on Risk Governance in a Complex Society.
57 Vormoor, Klaus (2010). Water Engineering, Agricultural Development and Socio-Economic Trends in the Mekong Delta, Vietnam.
58 Hornidge, Anna-Katharina, Kurfürst, Sandra (2010). Envisioning the Future, Conceptualising Public Space. Hanoi and Singapore Negotiating Spaces for Negotiation.
59 Mollinga, Peter P. (2010). Transdisciplinary Method for Water Pollution and Human Health Research.
60 Youkhana, Eva (2010). Gender and the development of handicraft production in rural Yucatán/Mexico.
61 Naz, Farhat, Saravanan V. Subramanian (2010). Water Management across Space and Time in India.
62 Evers, Hans-Dieter, Nordin, Ramli, Nienkemoer, Pamela (2010). Knowledge Cluster Formation in Peninsular Malaysia: The Emergence of an Epistemic Landscape.
63 Mehmood Ul Hassan, Hornidge, Anna-Katharina (2010). 'Follow the Innovation' – The second year of a joint experimentation and learning approach to transdisciplinary research in Uzbekistan.
64 Mollinga, Peter P. (2010). Boundary concepts for interdisciplinary analysis of irrigation water management in South Asia.
65 Noelle-Karimi, Christine (2006). Village Institutions in the Perception of National and International Actors in Afghanistan. (Amu Darya Project Working Paper No. 1)
66 Kuzmits, Bernd (2006). Cross-bordering Water Management in Central Asia. (Amu Darya Project Working Paper No. 2)
67 Schetter, Conrad, Glassner, Rainer, Karokhail, Masood (2006). Understanding Local Violence. Security Arrangements in Kandahar, Kunduz and Paktia. (Amu Darya Project Working Paper No. 3)
68 Shah, Usman (2007). Livelihoods in the Asqalan and Sufi-Qarayateem Canal Irrigation Systems in the Kunduz River Basin. (Amu Darya Project Working Paper No. 4)
69 ter Steege, Bernie (2007). Infrastructure and Water Distribution in the Asqalan and Sufi-Qarayateem Canal Irrigation Systems in the Kunduz River Basin. (Amu Darya Project Working Paper No. 5)
70 Mielke, Katja (2007). On The Concept of 'Village' in Northeastern Afghanistan. Explorations from Kunduz Province. (Amu Darya Project Working Paper No. 6)
71 Mielke, Katja, Glassner, Rainer, Schetter, Conrad, Yarash, Nasratullah (2007). Local Governance in Warsaj and Farkhar Districts. (Amu Darya Project Working Paper No. 7)
72 Meininghaus, Esther (2007). Legal Pluralism in Afghanistan. (Amu Darya Project Working Paper No. 8)
73 Yarash, Nasratullah, Smith, Paul, Mielke, Katja (2010). The fuel economy of mountain villages in Ishkamish and Burka (Northeast Afghanistan). Rural subsistence and urban marketing patterns. (Amu Darya Project Working Paper No. 9)
74 Oberkircher, Lisa (2011). 'Stay – We Will Serve You Plov!'. Puzzles and pitfalls of water research in rural Uzbekistan.
75 Shtaltovna, Anastasiya, Hornidge, Anna-Katharina, Mollinga, Peter P. (2011). The Reinvention of Agricultural Service Organisations in Uzbekistan – a Machine-Tractor Park in the Khorezm Region.
76 Stellmacher, Till, Grote, Ulrike (2011). Forest Coffee Certification in Ethiopia: Economic Boon or Ecological Bane?

ZEF Development Studies

edited by Solvay Gerke and Hans-Dieter Evers

Center for Development Research (ZEF), University of Bonn

Shahjahan H. Bhuiyan
Benefits of Social Capital. Urban Solid Waste Management in Bangladesh
Vol. 1, 2005, 288 p., 19.90 EUR, br. ISBN 3-8258-8382-5

Veronika Fuest
Demand-oriented Community Water Supply in Ghana. Policies, Practices and Outcomes
Vol. 2, 2006, 160 p., 19.90 EUR, br. ISBN 3-8258-9669-2

Anna-Katharina Hornidge
Knowledge Society. Vision and Social Construction of Reality in Germany and Singapore
Vol. 3, 2007, 200 p., 19.90 EUR, br. ISBN 978-3-8258-0701-6

Wolfram Laube
Changing Natural Resource Regimes in Northern Ghana. Actors, Structures and Institutions
Vol. 4, 2007, 392 p., 34.90 EUR, br. ISBN 978-3-8258-0641-5

Lirong Liu
Wirtschaftliche Freiheit und Wachstum. Eine international vergleichende Studie
Vol. 5, 2007, 200 p., 19.90 EUR, br. ISBN 978-3-8258-0701-6

Phuc Xuan To
Forest Property in the Vietnamese Uplands. An Ethnography of Forest Relations in Three Dao Villages
Vol. 6, 2007, 296 p., 29.90 EUR, br. ISBN 978-3-8258-0773-3

Caleb R.L. Wall, Peter P. Mollinga (Eds.)
Fieldwork in Difficult Environments. Methodology as Boundary Work in Development Research
Vol. 7, 2008, 192 p., 19.90 EUR, br. ISBN 978-3-8258-1383-3

Solvay Gerke, Hans-Dieter Evers, Anna-K. Hornidge (Eds.)
The Straits of Malacca. Knowledge and Diversity
Vol. 8, 2008, 240 p., 29.90 EUR, br. ISBN 978-3-8258-1383-3

Caleb Wall
Argorods of Western Uzbekistan. Knowledge Control and Agriculture in Khorezm
Vol. 9, 2008, 384 p., 29.90 EUR, br. ISBN 978-3-8258-1426-7

Irit Eguavoen
The Political Ecology of Household Water in Northern Ghana
Vol. 10, 2008, 328 p., 34.90 EUR, br. ISBN 978-3-8258-1613-1

Charlotte van der Schaaf
Institutional Change and Irrigation Management in Burkina Faso. Flowing Structures and Concrete Struggles
Vol. 11, 2009, 344 p., 34.90 EUR, br. ISBN 978-3-8258-1624-7

Nayeem Sultana
The Bangladeshi Diaspora in Peninsular Malaysia. Organizational Structure, Survival Strategies and Networks
Vol. 12, 2009, 368 p., 34.90 EUR, br. ISBN 978-3-8258-1629-2

Peter P. Mollinga, Anjali Bhat, Saravanan V.S. (Eds.)
When Policy Meets Reality. Political Dynamics and the Practice of Integration in Water Resources Management Reform
Vol. 13, 216 p., 29.90 EUR, br., ISBN 978-3-643-10672-8

Irit Eguavoen, Wolfram Laube (Eds.)
Negotiating Local Governance. Natural Resources Management at the Interface of Communities and the State
Vol. 14, 248 p., 29.90 EUR, br., ISBN 978-3-643-10673-5

William Tsuma
Gold Mining in Ghana. Actors, Alliances and Power
Vol. 15, 2010, 256 p., 29.90 EUR, br., ISBN 978-3-643-10811-1

Thim Ly
Planning the Lower Mekong Basin: Social Intervention in the Se San River
Vol. 16, 2010, 240 p., 29.90 EUR, br., ISBN 978-3-643-10834-0

http://www.lit-verlag.de/reihe/zef