RISK-BENEFIT ASSESSMENT FOR INTEGRATED FLOOD MANGEMENT: SUPPORTING SUSTAINABLE LIVELIHOODS IN DEVELOPING COUNTRIES

International Centre for Water Hazard and Risk Management, Public Works Research Institute and National Graduate Institute for Policy Studies Student Member ○Andrea Mariel Juarez
International Centre for Water Hazard and Risk Management, Public Works Research Institute and National Graduate Institute for Policy Studies Kelly Kibler

1. INTRODUCTION

Floods often are associated with negative impacts to properties and infrastructure as well as to humans. Regular flooding, however, may also sustain agricultural activities amongst other economic and environmental benefits (Few, 2003). Increased soil fertility, fisheries productivity, the recharge of shallow aquifers and replenishment of water bodies, sustained biodiversity or the provision of water for dry periods are examples of flood-derived benefits (Cuny, 1991). The Integrated Flood Management (IFM) concept captures these two sides of floods and promotes a conceptual approach in which benefits from the use of frequently inundated areas are maximized while potential damages from floods are minimized (APFM, 2004). In developed countries many IFM measures in practice consist of floodplain use adaptations for "making space for water", through river and wetland restoration, open levees and embankments or floodplain mapping and zoning regulations (Samuels et al., 2006). As compared to developed countries, distinctive trends and contexts in developing countries represent different types of pressures, for instance rapid population growth, urbanization, poverty and unsustainable development. Application of IFM in developing nations must therefore encompass somewhat different considerations in order to meet and cope effectively with local opportunities and constraints. Traditional flood risk assessment methods normally involve the analysis of flood inundations over a range of flow conditions to obtain probability exposure functions (Figure 1a), which are combined with relationships for tangible and intangible damages over a range of flood severities (Figure 1b) to determine probabilistic risk functions (Figure 1c) (Dutta et al., 2003; Meyer and Messner, 2005). Most risk assessment methods are based on flood damages evaluation only or consider benefits only in terms of prevented damages (Meyer and Messner, 2005). Direct benefits and opportunities related to use of flood-prone areas are often not explicitly included in such analyses, thus actual application of the IFM concept to risk-based land use planning and decision making is limited. The outcome of considering only damages and neglecting benefits in decision making may be the selection of flood risk management practices which alter magnitudes of peak flows and/or reduce the return period of floodplain inundations, activities which may reduce benefits associated with flood-adapted livelihoods. These other aspects of floods highlight the importance of including probabilistic benefits into flood risk assessments methods when identifying acceptable risk. The objectives of this research are to 1) develop quantitative methods for integrated analysis of risks and benefits related to use of flood-hazard areas, and 2) apply our methodology to identify optimal floodplain use adaptations under an IFM approach in the context of developing countries.

2. METHODS

We define a conceptual step-wise approach in order to integrate probabilistic benefits into traditional flood risk assessments (Figure 1a-1e). We assess flood risks by a) modeling flooding over several return intervals to obtain probability exposure functions, b) estimating damages functions and c) combining a) and b) to obtain probabilistic risk functions. We then undertake an analogous analysis to assess probabilistic benefits, including generation of d) functions relating benefits with flood severity and e) probabilistic benefit functions. We apply our methodology to evaluate optimal land use and adaptation strategies in several flood-prone villages in the Philippines.

2.1. Case study area

Candaba Swamp, located in Pampanga River Basin, Philippines, is a wetland of 250km^2. During the wet season, the area functions as a flood retarding basin (Yamashita et al., 2003). Local inhabitants, approximately 96, 589 people, of this flood-prone area pursue fishery activities during the wet season, while in the dry season land is converted into rice fields and plantations (BirdLife International, 2014).

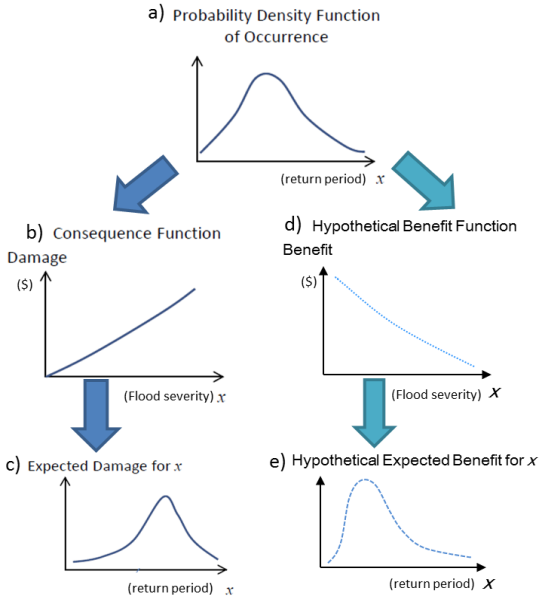

Figure 1. Flood risk-benefit step-wise approach

Keywords: Integrated Flood Management, flood risk assessment, flood benefits, land use, sustainable livelihoods, developing countries
Contact address: 1-6 Minamihara, Tsukuba, Ibaraki 305-8516, Japan, Tel: +81-(0)-29-879-6809

2.2. Development of Flood Risk-benefit assessment

We conduct risk-benefit assessment in the Candaba Swamp area, evaluating risk according to the protocol described in the River and Sabo Technical Standard of Japan (2012). We apply the Rainfall-Runoff-Inundation model (Sayama, 2012) over several return intervals of flow to evaluate flood exposure. We assess flood-related damages to agricultural productivity as described in the Manual on damage assessment and reporting system (Philippine Bureau of Agricultural Statistics, 2013). Similarly to damage functions, we create benefit functions to relate flood benefits with flood severity. In order to localize the risk-benefit models with respect to specific categories of damage and benefit assessed, we undertake field surveys to identify dominant local livelihoods and the extent to which they are adapted to seasonal flooding.

3. RESULTS AND DISSCUSSION

In Candaba Swamp, local people engage primarily in fishery (aquaculture and capture fishing) and agricultural-based livelihoods. While some people perform one activity only on a yearly basis, others alternate fishery production during the wet season with agriculture (e.g. rice, corn, watermelon, others) during the dry season. Preliminary results of the risk-benefit assessment indicate that such seasonal land use adaptation is associated with maximum benefit of flood-prone land use. In some cases, adapted land uses are associated with greater damage risks but generate greater net benefits in economic terms. In the contrary, non-adapted land uses involve less damage potential but fewer benefits. Results indicate that the use of floodplains provide greater livelihood benefits than an exclusion use, such as in an exclusive conservation scenario. Risk-benefit profiles associated with the spectrum of adapted and non-adapted land uses provide vital information for decision-makers to evaluate which are or could be optimal and preferred measures for maximizing benefits and reducing risks. The implications for developing countries is that certain land use types and adaptations can then be selected and promoted with a strong basis of securing livelihoods through optimization of flood risk and benefit. Furthermore, the approach provides opportunity to identify measures which may achieve integrated and sustainable ecosystem conservation and reduction of poverty, based upon needs and interests of local people.

4. CONCLUSION

Flood risk assessments based solely on damages may overlook opportunities for adaptation and coping capacities. On the other hand, considering both risks and benefits of inhabiting flood-prone areas may identify opportunities for maximizing beneficial use of floodplains while minimizing flood damages. In the case of developing countries, many benefits of floods and floodplain use contribute substantially to local livelihoods or represent entirely the main source of income. People residing within floodplains most likely will continue to live in flood-prone areas; therefore there is a need to find ways to cope with flood risk. Our quantitative method for integrated assessment of probabilistic flood damages and benefits may identify adaptation strategies which enhance benefit and reduce risk of losses. Such mechanisms can allow for greater flexibility in coping with climate and livelihood uncertainties. This is essential especially for the formulation of adaptive measures that could also combine multiple objectives and enhance resiliency. Such quantitative risk-benefit assessments represent an important tool for materializing conceptual IFM principles into practical experiences.

REFERENCES

Associated Programme on Flood Management (APFM): Integrated flood management concept paper, APFM Technical Document No. 1 (second edition), World Meteorological Organization, Geneva, Switzerland, 2004.
BirdLife International: Important Bird Areas factsheet: Candaba swamp, Downloaded from http://www.birdlife.org on 2/2/2014, 2014.
Bureau of Agricultural Statistics: Manual on damage assessment and reporting system, Department of Agriculture, Philippines, 2013.
Cuny, F.C.: Living with floods: Alternatives for riverine flood mitigation, Land Use Policy, 8-4, 1991, pp. 331-342.
Dutta, D., Herath, S., & Musiake, K.: A mathematical model for flood loss estimation, Journal of Hydrology, 277-2003, 2003, pp. 24-49.
Few, R.: Flooding, vulnerability and coping strategies: local responses to a global threat, Progress in Development Studies, 3-1, 2003, pp. 43-58.
Meyer, V., and Messner, F.: National Flood Damage Evaluation Methods, A Review of Applied Methods in England, the Netherlands, The Czech Republic and Germany, UFZ-Discussion Papers, Dept. of Economy, Leipzig, Germany, 2005.
Ministry of Land, Infrastructure, Transport and Tourism: River and sabo technical standard, investigation, 2012.
Samuels, P., Klijn, F., and Dijkman, J.: An analysis of the current practice of policies on river flood risk management in different countries, Irrigation and Drainage, 55-S1, 2006, pp. S141-S150.
Sayama, T., Ozawa, G., Kawakami, T., Nabesaka, S., and Fukami, K.: Rainfall-Runoff-Inundation analysis of the 2010 Pakistan flood in the Kabul River basin, Hydrological Science Journal, 57-2, 2012, pp. 298-312.
Yamashita, N., Ohmoto, T., and Nishino, K.: Flood Mitigation Effects and Sedimentation Function of Candaba Swamp within Pampanga River Basin in the Republic of the Phillipines, Paper presented at the XXX IAHR Congress, Thessaloniki, Greece, 2003.