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Are floods in part a form of land use externality

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On a river basin scale a lot of processes and developments are linked via hydrological processes and the river system. Land use like agriculture or settlement, river training, detention or technical flood protection are samples of human actions that influence the run-off regime. In the linked environment of a river basin upstream actions can influence downstream stakeholders. Land use itself or restrictions are always closely linked with economic consequences for different interest groups and actors, lowering incomes, protecting or increasing the value of property. Effects of land sealing, draining, river development and diked forelands have been evaluated during the last years. General statements about the level of increase of floods can not be made. But it can be stated, that depending on the local situation in the catchment all these effects cause an increase of flood peaks and the shape of a flood wave. On a plot and micro scale these dependencies have been proven, on a meso scale these dependencies can be quantified and on a macro scale they can be estimated. In economic theory costs, that are not included in the production costs and are exported to third parties, for example pollution and its social costs, are called externalities. They exist because people can use a resource without a compensation for its use. This is especially a problem of public and common goods like air or water. As we see also the effects of land use on flood development can be called an externality of land use. If we take a rivulet or river as a system with a unidirectional transmission of effects from the head to the tailwater, land users can export their costs of production fully to the people downstream. This is a special form called unidirectional externality. From an economic point of view it is now of interest up to which extent flood related costs like flood damages or costs for flood defense are such externalities or just results of a natural hazard. This is of importance to evaluate whether and how legal and economic counter measures, called internalization, can be used. For a small rural catchment with 72 km^2 catchment size these dependencies have been evaluated. A combination of hydrological model,

hydrodynamic model and cost effectiveness analysis was used. With a combination of hydrological regionalisation, flood and pond routing different land use and river structure scenarios have been evaluated and their effect on the flood behavior was identified. In a second step impacts of these flood waves on settled areas have been simulated using a 2D stream flow model. Last step was an economic comparison of land use and flood defense scenarios to estimate the amount of land use externalities using the instrument of cost-effectiveness analysis. The study showed, that land use and river structure have an impact on flood related costs. Depending on the location in the catchment, severity of human changes in the river structure and intensity of agricultural land use flood behavior changed flood related costs. Flood peaks, relevant volume of a flood wave or both increased in such a way, that either potential damages or costs for effective flood detention rose significantly. As a consequence changes in agricultural subsidies or urban development enforced by internationalization strategies could have significant effects on flood prevention through sustainable land use or regain increased costs for flood defense or damages. They could be seen as a parallel to splitted waste water fees invented to reduce costs of sewage systems as an incentive for avoided influx or recover increased costs. Internalizations could be an important module of flood risk management in small and maybe medium size catchments. The study showed that a combination of engineering modeling techniques and economic analysis could help in flood prevention to reduce societal costs and optimize welfare through reduced floods and sustainable land use.