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THE ENVIRONMENTAL IMPACTS OF FLOODING IN ST. MARIES, IDAHO

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INTRODUCTION

All natural disasters create adverse impacts when they damage buildings, destroy possessions, and compromise the integrity of structures. Planning for such events and implementing mitigation measures is fairly common, at least in the United States where building codes, land-use regulations and other measures are often adopted to minimize potential losses. In contrast, these impacts are not usually taken into account when developing or redeveloping hazardous areas, and even less concern is given to any environmental assessment of development decisions with regard to hazards. This is somewhat surprising, since hazards invariably create secondary environmental impacts that can have severe repercussions for society. For instance, following the 1993 Mississippi River floods, more than \$34 million were allocated to the Environmental Protection Agency to deal with a range of environmental concerns (Clinton, 1993). Additional money was spent by local and state governments to alleviate other environmental impacts associated with polluted water supplies and the safe disposal of solid wastes. Such unanticipated damages can also slow the recovery process by raising costs and complicating remedial action plans. Furthermore, failure to accommodate such potential impacts into the planning process only serves to perpetuate the problems. Inevitably, it seems, disasters lead to damages, and then repairs merely recreate the status quo. It would seem appropriate, therefore, to consider environmental impacts in the development of hazardous areas as an input into the decision-making process.

This paper looks at the range of environmental impacts of flooding as they exist immediately following an event. The flood hazard is then seen

as a strategic problem that can be addressed through environmental impact assessment techniques.

ENVIRONMENTAL ASSESSMENT AND THE FLOOD HAZARD

The occurrence of a flood event usually elicits a response to alleviate losses and return society as quickly as possible to pre-disaster conditions. It is rare to find long-term strategic planning designed to mitigate the many facets of the flood hazard. In part, of course, this is because floods are often low-probability events that do not rank highly amongst the many issues that people face on a day-to-day basis. In addition, many societies have implemented emergency action plans to facilitate the immediate relief of flood victims, which tends to work against the development of comprehensive disaster planning (White, 1975; Williams, 1986). Also, it should be noted that some events are relatively unpredictable, at least in time if not in space, thus compromising effective planning while promoting a simple response mode. However, despite these characteristics, the opportunities for evaluating probable impacts of a given event and for planning accordingly are considerable.

Some progress has been made, particularly with the National Flood Insurance Program and its associated zoning regulations and floodproofing requirements that place restrictions on new development (Federal Interagency Floodplain Management Task Force, 1992). The intent is to minimize reliance on flood control structures, to phase out uneconomic development, and to force floodplain residents to insure against individual losses, thus reducing the need for community-based relief. Nevertheless, with the exception of water and sewage systems, environmental impacts of development are generally ignored.

Reasons for this lack of consideration of environmental impacts emanating from flooding are relatively straightforward. Most basically, flood concerns have historically been regarded as economic issues

associated primarily with direct damages. In essence, the underlying philosophy has been one of costs versus benefits, while focusing attention on short-term economic variables, rather than consideration of the total range of impacts, including indirect and intangible losses (Handmer, 1988). Secondly, there has been overwhelming interest in relief and rehabilitation efforts and a prevailing desire to get things "back to normal" as soon as possible. Thus, the first step is usually to facilitate economic recovery from the flood and to meet the immediate demands of flood victims. The second step, it seems, is to plan for the next event, thereby initiating a continuing cycle of disaster-relief- repair-disaster. Ultimately, the flood risk and vulnerability do not change. Of course, society can and does learn from some events, to the extent that some communities have even moved off the floodplain, but these tend to be the exceptions rather than the rule (Alto, pers. comm., 1995; Tobin, 1992).

The environmental impacts of flooding can be quite wide-ranging, from the dispersion of low-level household wastes into the fluvial system to contamination of community water supplies and wildlife habitats with extremely toxic substances. On the other hand, flood preparedness activities, such as forecasting and warning systems, can help to avoid some of these impacts. Indeed, actions undertaken prior to the event will have repercussions on the level of damages accruing from the flood. Effective remedial actions, such as sandbagging, can significantly reduce losses, and with planning, prevent some of these secondary environmental impacts. Specifically, the removal of fuel tanks and attention to hazardous wastes would eliminate some of the potential problems. In contrast, inadequate attention to these components of the flood hazard will invariably lead to additional problems and intensify adverse environmental impacts. Similarly, during a flood, variables such as depth of water, velocity of flows, and duration of inundation, in combination with land-use attributes, all contribute to the relative severity of flood impact (Tobin and Montz, 1994). Floods of greater depth are likely to result in greater environmental damage than floods of lesser magnitude, in part because more area has been flooded. Long duration floods will exacerbate environmental problems because clean-

up will be delayed and contaminants may remain in the environment for much longer time. The argument is the same for other flood traits; extreme conditions are likely to precipitate additional environmental problems.

During the post-flood phase, that is the clean-up stage, many other environmental impacts can become apparent. The volume of the debris to be collected, the extent to which public utilities such as water supply systems and sewage operations have been damaged, and the quantity of agricultural and industrial pollutants entering fluvial systems might present pressing problems. These findings, then, should be incorporated into long-term restoration and reconstruction programs to eliminate unacceptable environmental impacts from subsequent flooding.

Environmental evaluation of the flood hazard, therefore, sets the stage for the strategic assessment of redeveloping flood prone areas.

Specifically, recurring losses and negative intrusions into environmental systems could be avoided, or at least minimized, by identifying, measuring, and interpreting the magnitude and significance of environmental impacts associated with flooding.

Currently, there is a tendency to re-analyze the economics of redevelopment in the aftermath of an event, and rebuild with future losses in mind, assuming the provisions of the NFIP are met. It follows that a similar approach regarding environmental impacts would provide a comparable basis for decision-making. The guiding principle in this instance would be reducing costs related to environmental clean-up and providing additional protection.

Strategic environmental assessment (SEA) has been defined as "the formalized, systematic and comprehensive process of evaluating the environmental impacts of a policy, plan, or program, and its alternatives . . . and using the findings in publicly accountable decision-making" (Therivel et al., 1992). The application of this definition to flooding is apparent. Reconstruction of floodplains is a policy that is enabled through federal and state disaster relief funding and private money. Traditionally, this has followed the simple economic model discussed above. However, strategic assessment of floodplain reconstruction permits a comprehensive analysis of policy decisions, prior to the

emergency phase immediately following a flood event. Since this is usually a period of chaos and confusion, such planning is essential if meaningful policies are to be implemented.

METHODOLOGY

SEA can provide a tiered approach to facilitate decision-making by focusing attention on specific attributes of a particular program or policy, while maintaining a comprehensive perspective. For example, the environmental impacts of the flood hazard can be assessed both from a theoretical perspective and a practical viewpoint. The theoretical provides the broad range of potential environmental impacts, as well as a framework for comparisons of policy alternatives, while the practical entails a site-specific analysis, incorporating facets of the local context. However, methods of strategic environmental assessment are generally not clearly formulated of the broad temporal and spatial scales involved (Wood and Djeddour, 1992). As a result, site-specific analyses are needed to provide a methodological base (Smith, 1993).

For the purposes of this research, we have utilized a simple matrix ([Figure 1](#)), that would have relevance to workers in the field, to determine the immediate environmental impacts of flooding. Such an approach made it possible to evaluate impacts as they "flowed" through different components of the environment during the flood event, while also accounting for different spatial and temporal scales.

The matrix provided a framework, then, for identifying a range of potential environmental impacts. The matrix comprised three "stages" of flooding, pre-flood, flood, and post-flood, that would possibly affect the outcome of environmental impacts. Data were collected on components of the hydrologic, and ecologic/habitat systems, as well as on specific land-uses, structures and appurtenances, utilities, and transportation networks in the floodplain. A preliminary determination was made as to whether the impacts were severe or of small magnitude in each appropriate category. Spatial scale can be accounted for by using

different matrices for each unit within the floodplain.

FLOODING IN ST. MARIES, IDAHO

St Maries, Idaho, is a small town of less than 3,000 residents, situated just below the confluence of the St. Joe and St. Maries rivers in northern Idaho. Its history is inextricably bound up with the fortunes of the timber industry and more recently with those of the Potlatch Company that now owns the major sawmills in the community (Conley, 1982). Indeed, the fate of the town has been a series of booms and busts as fires and floods have repeatedly affected the community. In spite of this, the town, incorporated in 1889, has remained the county seat since 1888, and continues to depend on timber and to utilize the river for the transportation of logs (Boone, 1988).

Flood History

St. Maries has experienced at least five devastating floods over the last 100 years, including those in 1917, 1933, 1948, 1974, and the most recent in February 1996. In addition, there have been numerous smaller events that have inundated lower areas of the community. The 1933 flood remains one of the largest on record with over 53,000 cubic feet per second (cfs) recorded at its peak upstream at Calder. This compares with 46,000 cfs in 1974 and probably a comparable flow in 1996 (St. Maries Gazette Record, 1974a).

Floods in St. Maries have usually occurred as a consequence of rapid snowmelt and/or heavy rainfall on already saturated catchments. Occasionally ice jams have precipitated additional problems. A further hydrological concern is the power dam, built in 1906 downstream at Post Falls, that causes water to back up into St. Maries at times of high flows. During floods, therefore, water cannot escape downstream, if lake levels at Post Falls are high. Thus, to some extent, levels and duration of flooding are contingent upon operation of the dam at Post Falls (Currier, pers. comm., 1996).

Response to the flood hazard at St. Maries has been typical of many floodplain communities. Small-scale, local, and ad hoc projects typified the first part of this century, and it was not until after the 1933 event that more serious consideration was given to protecting the community from flooding. This interest corresponds to the gradual involvement of the federal government in flood alleviation programs. Thus, by the early 1940s, the US Army Corps of Engineers (USACE) had erected dikes along the southern bank of the St. Joe River (Coeur d'Alene Press, 1996). Since then, the levee system has grown in height and extent so that there are now eight levee districts within the town, although only one is currently an official USACE structure. The two major levees, Meadowhurst and Riverdale, are 14,000 and 11,000 feet long, respectively, and protect large tracts of the town. With the construction of levees, small-scale flooding has been virtually eliminated, and major events are now associated with failures in one or more of the dikes. The next stimulus for remedial action was the flood of January 1974. On this occasion, an ice jam and heavy rain combined to breach the Riverdale and Burden House levees and put serious pressure on the Meadowhurst levee (St. Maries Gazette Record, 1974a). Levees were reported to be like "jelly" and were reinforced with sandbags, as saturation continued for some time. It was in the months immediately after this event that city authorities passed a resolution calling for a floodplain ordinance as a first step to joining the NFIP (St. Maries Gazette Record, 1974b). This was accomplished in May of that year when the Department of Housing and Urban Development approved the ordinance (St. Marie s Gazette Record, 1974c). Each of these floods not only devastated homes and businesses, but also wreaked havoc on the environment. For instance, the presence of timber mills on the floodplains meant that during every flood, fuels and other contaminants were carried away by flood waters. Similarly, household products, chemicals, and agricultural pollutants would have been washed into the fluvial system. In 1974, \$5.5 million damage (1974 figures) was recorded for the county, which included damage to water supplies and sewage plants (St. Maries Gazette Record, 1974a). In addition, soil loss was reported from agricultural areas.

Thus, while St. Maries had joined the NFIP in 1974, very little of consequence had changed in the community that would prevent future floods, and nothing had been done to contain environmental contamination. By 1996, the last major event had occurred over twenty years earlier, so although the event probably remained a life benchmark for individual residents, it would have been of little practical value in fighting this most recent flood. Indeed, the community typifies the classic response to the flood hazard, with its almost total dependence upon a single flood alleviation measure, in this case, the levee system. While these structures have been very effective up to their design standards, they have failed, as shown in the past, and development on the floodplain has continued in spite of NFIP regulations. For instance, in 1995 Potlatch spent \$6 million updating the dry kiln located in the most frequently flooded part of the town (Coeur d'Alene Press, 1996). The vulnerability of the community to the flood hazard, therefore, has not been altered.

The February 1996 Flood

On Wednesday, February 7, at 1:05 p.m., following four days of heavy rain, a preliminary flood warning was issued for the St. Joe River. However, while flows remained high, it was only when the freeze level rose from 3,500 to 9,000 feet, rapidly melting the snow, that serious problems ensued. The rain fall and snowmelt on an already saturated catchment, combined with a small ice jam led directly to flooding. By the evening of February 8, the airport was closed because both ends of the runways were under water, and lower parts of the valley were already flooded. The National Weather Service issued a new forecast for peak river levels between 2140 and 2142 feet, which meant flooding in St. Maries was imminent because the levee system only protected to 2139 or 2140 feet. By 9:10 p.m. preparations were being made to evacuate residents in some areas along the St. Joe River. By 8:00 a.m. the next day, a revised National Weather Service forecast estimated levels in excess of 2.5 feet above the level of the dikes along the St. Joe River (St. Maries Gazette Record, 1996b).

By the morning of February 9, the levee system was in jeopardy. Leaks were detected on the Riverdale dike, and boils were observed in other districts. Attempts to plug leaks with sandbags were eventually abandoned for safety reasons. Several hours later, both the Meadowhurst and the Riverdale dikes were breached, flooding over 850 acres and more than 100 homes and 20 businesses (Coeur d'Alene Press, 1996; St. Maries Gazette Record, 1996b). This levee failure caused a temporary fall in flood levels until the floodplain filled with water. Other dikes also failed, including one protecting the airport, leading to the inundation of another 486 acres. By the end of the flood, there were two major breaks in the Riverdale dike, one 250 feet long, the other 40 feet in length. As the levees were repaired, pumps were installed to get water out of the low-lying areas. At one time, 43,000 gallons of water per minute were being pumped out of the Meadowhurst levee area (Currier, pers. comm. 1996). Water remained in the community for approximately three weeks. Both the St. Maries and the St. Joe Rivers were contributing to the flooding. Unfortunately, there are no gauges on the St. Maries River, which presents difficulties for forecasting flood events with any degree of accuracy. Hydrological models, however, indicate that the St. Maries River usually contributes about 30% of the total flows, although this probably varies given different storm events (Currier, pers. comm., 1996).

ENVIRONMENTAL DAMAGES AND IMPACTS

Estimates of flood damage were put at \$17 to \$18 million (St. Maries Gazette Record, 1996a). Perhaps the most significant losses occurred when the dry kiln of Potlatch was inundated, closing production of green cedar products for about three weeks, and the whole Potlatch complex for two days during the peak of the flood. It was suggested that, although only 10 to 20 people worked in the dry kiln area, over 40% of local jobs hinged on the operation of the dry kiln (Coeur d'Alene Press, 1996). The

long-term consequences for the community, therefore, could be serious. Federal aid to area residents and business persons came from federal agencies such as the Federal Emergency Management Agency (FEMA) and the Small Business Administration (SBA). FEMA provided \$1.5 million dollars to hire displaced workers to help with the clean up. Another, \$500,000 was provided to extend unemployment benefits, while \$6 million came from federal transportation funds to fix roads and bridges in northern Idaho (Idaho Spokesman-Review, 1996). Additional expenditure came from the Environmental Protection Agency (EPA) in monitoring some of the environmental impacts.

Power was lost for a time, and the city sewage works was also damaged (St. Maries Gazette Record, 1996b). The sewage plant was flooded relatively early, and wastewater came over the top of the levee (Currier, pers. comm., 1996). Flood water entered the primary treatment area and excess wastes were pumped into the ground and river. Most of the city residences are connected to the city sewer system, although there are a few septic tanks in the Riverdale area. These, however, are connected to the main system through a series of pumping stations (Municipal Public Works Foreman, pers. comm., 1996). However, city authorities reported no major contamination associated with flooding of the sewage works, although no testing was undertaken.

A boil water order was issued by the Department of Environmental Quality on the basis that sewage, petroleum products, and micro-organisms could have contaminated supplies (St. Maries Gazette Record, 1996a). There was some criticism of this order, since St. Maries uses surface water brought from eight miles upstream at Rochat Creek and only utilizes a local well if surface supplies are short (Municipal Public Works Foreman, pers. comm., 1996). However, high turbidity levels, not unusual for this location, were used to argue for the order.

POST-FLOOD ASSESSMENT

The Environmental Protection Agency collected approximately 260

containers that had been inundated and were either floating around in flood waters or were under water. Of these, 241 had been recovered from the Meadowhurst district, 17 from Riverdale, 59 from north of the town, and 5 were brought in by residents. Many of these had been used for home fuel, such as kerosene; for the storage of lubricants, hydraulic oils, grease, petroleum products, and other waste oils; and for heavy duty cleaners and household chemicals. Some of the barrels were punctured and their contents had leaked out, while others were open. It was thought that most of these had come from residences and businesses located in the Meadowhurst and Riverdale areas. In fact, there are numerous small businesses which would use such materials, including automobile repair operations and activities associated with wood products. In addition, Potlatch had a 1,000 gallon fuel tank in the flood waters and several other fuel tanks were floating around the airport (Rodin, pers. comm., 1996).

It appeared that no serious contamination had resulted from the flood, although some materials were tested to see if they were hazardous. Of the 238 samples tested, 107 proved positive. Chemical testing revealed primarily oils, grease, and some household chemicals, along with some agricultural pesticides, acids, and paints. Quantities were variable, with containers ranging from 1 to 55 gallon drums. Not all of these were full; many had clearly leaked into the surrounding environment. Barrels were stored temporarily at a landfill during the flood, eventually to be sent to a RCRA facility if hazardous. Visible evidence of contamination was not high. In places there was a thin film on the top of the flood water from petroleum and hydrocarbons, most of which was expected to dissipate or mix into soils. There was a possibility that such products could get into groundwater depending on the depth and condition of wells. Some of the contaminated areas had been boomed and absorbent materials used to soak up the wastes (Rodin, pers. comm., 1996).

THE SURVEY MATRIX

The barrels discussed in the previous section represent only one source

of environmental impact. There are others, which can act singly and in combination to create the overall environmental impact of the flood. The matrix in [Figure 1](#) provides one means of identifying and analyzing the nature and range of impacts and serves as the first step in the strategic analysis of the environmental impacts of flooding.

The vertical axis of the matrix includes those environmental parameters that are expected to be affected by flooding, no matter what the location. The horizontal axis includes the activities or characteristics associated with flooding that are expected to cause an impact on one or more environmental parameters, whether positive or adverse. Those cells with a checkmark indicate a relationship between the activity and the environmental parameter. A more in-depth analysis of a flood event would allow for some measurement, if only relative, of the magnitude of these impacts. While this is preferred over the identification of impacts in [Figure 1](#), sufficient data are not available for reliable measurements. Additional long-term research is required to develop measures of anticipated magnitudes. Nonetheless, some observations can be made from the matrix.

The range of impacts from different flood characteristics can be determined by reading down from a given category of activity. For instance, the existence of opened and leaking barrels in the flood area may have potential impacts on surface water and groundwater quality, on aquatic habitat and species, and on different land uses, depending on the amount and type of contaminants involved. In addition, the number of flood-related characteristics or activities that affect a given environmental parameter can also be identified. For example, surface water quality will be adversely affected by the velocity, depth, and duration of flooding as well as by flooding of the sewage treatment plant, by the tanks and barrels in the flooded area, by household hazardous wastes in the flooded area, and by debris and mud removal. As a result, water quality is subject to numerous intrusions, which, both separately and in various combinations, can be significant depending upon the contaminants released. Costs of dealing with this can be high, in terms of real dollars as well as environmental costs if contaminants move through ecological systems. And surface water quality is just one

parameter affected.

CONCLUSIONS

Given the data available immediately following the flood in St. Maries, it is difficult to determine even relative measures of the magnitude of environmental impacts. Reports by local officials suggest that the impacts were small and not significant. The EPA's data show hundreds of barrels and containers in the flood water, with small quantities of household chemicals, oils, and grease being the main constituents found in the containers. For such a small community the number of barrels was astounding. Of further concern was the fact that many barrels were either unmarked or contained foreign substances, making clean-up operations more difficult. This lack of knowledge, therefore greatly complicated the task of the EPA. It also suggests that the environmental impacts from flooding in larger communities, especially where there is heavy industry, might constitute a significant problem. This is supported by examination of the matrix in [Figure 1](#) which illustrates the large number of impacts that are likely to have occurred.

This study indicates that some refinement in the ability to measure environmental impacts is needed. The overall approach appears to have merit and provides a useful framework for identifying potential environmental problems. Certainly the elements included in the matrix have relevance to St. Maries, as well as to other floodplain areas. As mentioned previously, however, the magnitude of impact could not be assessed, given the data available at the time of this research. Additional work is required. Nonetheless, the utility of the matrix in post-flood St. Maries suggests that it has the potential for wider application in pre-flood communities, where the exposure of environmental parameters to flood characteristics can be estimated prior to an event.

In the final analysis, therefore, assessment of the environmental impacts of flooding involves consideration of a range of interactions that do not usually enter floodplain management decisions, at least in any systematic way. It may be argued that flooding at a place is a rather rare

event, and as a result, associated environmental impacts are equally rare and generally insignificant in the short-term. Yet, when we consider the flood hazard in the United States as a whole, environmental impacts are devastating. Losses from flooding are estimated to be up to \$3 billion per year, a considerable proportion of which is spent by local, state, and national agencies on clean-up operations involving environmental problems (Federal Interagency Floodplain Management Task Force, 1992).

Because of recurring and ever increasing economic losses due to flooding, new policies have been implemented, most notably the NFIP, which to some extent account for flood risk. Consequently, there are now restrictions on floodplain development in over 18,000 participating communities (Emergency Information Public Affairs, 1995). A similar strategic approach, based on nature, magnitude, and significance of impacts, is recommended with environmental losses. To date this has not been done, in part because it has not been of sufficiently high priority to merit consideration. However, as the environmental impacts of the St. Maries indicate, environmental impacts and risks can be considerable.

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Figure 1 - Matrix for Studying Ecological Effects of Floods

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