World Meteorological Organization

THE ROLE OF LAND-USE PLANNING IN FLOOD MANAGEMENT

A Tool for Integrated Flood Management

ASSOCIATED PROGRAMME ON FLOOD MANAGEMENT

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The Associated Programme on Flood Management (APFM) is a joint initiative of the World Meteorological Organization (WMO) and the Global Water Partnership (GWP). It promotes the concept of Integrated Flood Management (IFM) as a new approach to flood management. The programme is financially supported by the governments of Japan and the Netherlands.

The World Meteorological Organization (WMO) is a specialized agency of the United Nations. It coordinates the activities of the meteorological and hydrological services of 188 countries and territories and such is the centre of knowledge about weather, climate and water.

The Global Water Partnership is an international network open to all organizations involved in water resources management. It was created in 1996 to foster Integrated Water Resources Management (IWRM).

Note for the reader

This publication is part of the "*Flood Management Tools Series*" being compiled by the Associated Programme on Flood Management. The contained Tool for "The Role of Land-Use Planning in Flood Management" is based on available literature, and draws findings from relevant works wherever possible. This Tool addresses the needs of practitioners and allows them to easily access relevant guidance materials. The Tool is considered as a resource guide/material for practitioners and not an academic paper. References used are mostly available on the Internet and hyperlinks are provided in the "References" section.

This Tool is a *"living document"* and will be updated based on sharing of experiences with its readers. The Associated Programme on Flood Management encourages flood managers and related experts engaged in environmental assessment around the globe to participate in the enrichment of the Tool. *For the purpose comments and other inputs are cordially invited.* Authorship and contributions would be appropriately acknowledged. Please kindly submit your inputs to the following Email address: apfm@wmo.int under Subject: "The Role of Land-Use Planning in Flood Management Tool".

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THE ROLE OF LAND-USE PLANNING IN FLOOD MANAGEMENT

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1. INTRODUCTION

1 The way land resources are utilized has a decisive influence on development prospects of societies. In many places the most valuable land resources in terms of soil fertility, urban development space, infrastructure location (e.g. transport links) etc. are liable to flooding. Taking a closer look at the issue of flooding, there are two major aspects that connect land use and flooding:

- The location of values and key components of the economy on flood plains provides economic benefits (i.e. the primary reason for developments being placed there) and at the same time creates risks for the society in terms of flood loss potential.
- The development of land has consequences on the flow of water on the one hand, either by accelerating runoff through reducing the infiltration capacity of soils or obstructing the natural drainage system, as well as sediment and pollutants on the other hand.

2 Naturally, since these processes are better understood for a couple of decades, calls have been that planning practices in the different sectors and groups dealing with land use planning on the one hand and flood protection or flood risk management on the other, should be interlinked or harmonized.

3 In its worst form a traditional and reactive approach would be to develop flood prone land without knowledge of the prevailing flood hazards, and to provide local flood defences for the area in an ad-hoc manner once flooding has occurred. Contrary, the approach promoted in this tool and largely recognized as the way forward is to take development decisions based on the knowledge of the prevailing and expected future risks and to adapt development planning according to the degree of risk faced and the risk a particular society is willing and able to accept.

1.1 Aims and Target Group

4 This Tool aims to:

- Identify the processes and policy principles that necessitate a linkage of land use planning in integrated flood management
- Provide an overview of land use planning instruments considered applicable in the flood management context
- Identify the challenges and opportunities to a closer linkage between the various sectors concerned
- Provide guidance as to how those sectors can work together

5 The Tool is primarily written for flood managers at municipal and higher administrative levels to facilitate the necessary dialogue with land use planners on local, regional and catchment levels, urban and agricultural planners, transportation planners, developers of individual land parcels etc.

6 In Chapter two the reader is getting exposed to the elements of flood risk (hazard, damage potential, vulnerability) and how land use interacts with each of those elements. In Chapter three the processes of flood management and land use planning are analyzed to provide a better understanding of possible points of interaction between those processes and the prevailing challenges faced in doing do. Chapter four provides an overview of various paths of Government intervention for managing development under flood hazard conditions as well as a number of major practical issues that need to be considered in the intervention process. Chapter five proceeds to highlight legal and institutional framework requirements, and enforcement aspects.

1.2 Flood Risk Mitigation

7 Land in many parts of the world is a scarce but crucial natural resource. Ongoing developments such as population growth and connected issues of food security and urbanization put

land and water resources under considerable pressure. Looking at the development history of societies it becomes evident that floodplain areas have been preferred for human settlement.

8 Some of the reasons for this development in the past have been the readily available natural resources such as fertile soils and abundance of water resources, readily available livelihood opportunities in agriculture and fisheries; transport links and access to markets for economic goods. The human response to the prevailing flood hazard on those lands has in most cases been based on the construction of flood defences, especially levees, storage reservoirs, floodwalls, and diversions. Modern flood management approaches employ, however, a much wider array of flood management measures, both structural and non-structural.

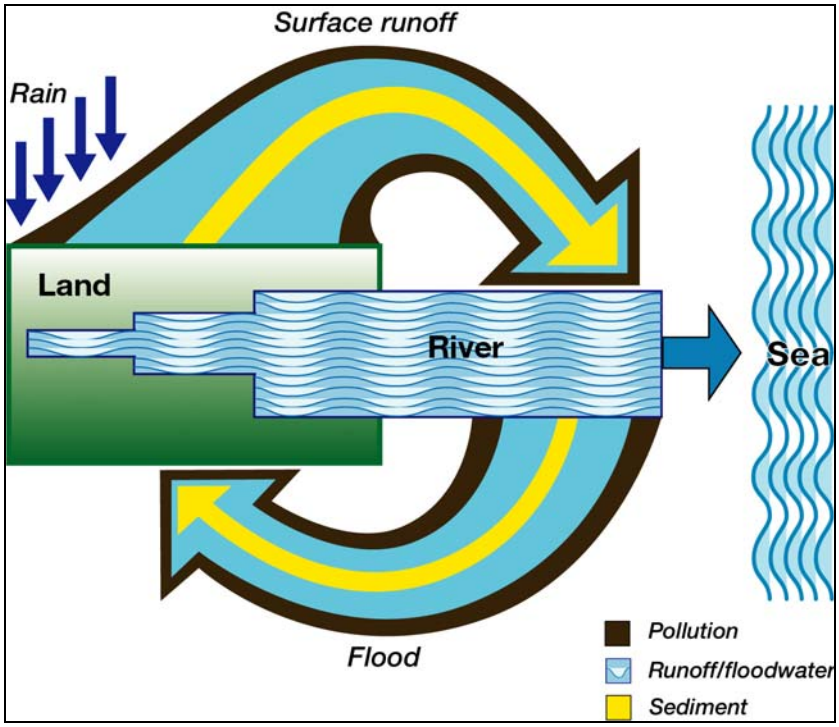
9 While the contribution of those flood-liable lands and the flood protection infrastructure to socio-economic development need to be recognized, the growing risks to the development process have become evident over the past decades in numerous examples of large scale flooding with serious economic consequences. Flood risk in its most essential form is the product of probability of a particular flood event times the consequence that event would have. In another form flood risk is described as a function of the flood hazard (probability of occurrence of a particular flood event), the exposure of human activity to the flood (flood damage potential) and the specific vulnerability of the community affected by the flood.

10 The level and trends in accumulating economic values on floodplains, in particular in form of “urban uses” encroaching on the flood plain, has in parts of the world led to discussion on acceptable levels of flood risk and in case led to considerable changes in national flood management policies towards limiting the flood damage potential by anti-encroachment policies. Integrated Flood Management (IFM) as a development policy concept calls for a balance between the development needs of society and the flood risks oriented towards the maximization of net-benefits derived from the flood plains to ensure sustainable development (APFM, 2004).

2. LAND-USE AND FLOOD RISK

2.1 Interactions between the land and water environment

11 River basins are dynamic systems constituted by a complex arrangement of fluxes between the land and water environment. There are essentially three interconnected fluxes, not only of water but also of sediments/nutrients and pollutants. Surface runoff caries sediments, nutrients and pollutants from the land through the river system, and as flooding occurs onto the floodplains as illustrated in Figure 1. It is important to note that those fluxes are varying over time and space. Natural geomorphologic processes influence those fluxes to varying degrees. For instance, natural phenomena such as land slides can have a significant influence on the sediment loads of adjacent water courses. Those sediments are deposited in the drainage systems, reducing the conveyance capacity of the channel and thus increasing the likelihood of flooding. Human alterations of the catchment area can significantly contribute to changes to all those processes through large scale land use changes and land-use practices.



(Source: APFM, 2004)

Figure 1: Interaction between land and water environment

12 An important process occurring during flooding is the extension of those fluxes into the floodplain, leading to the deposition of sediments on the land. This has over the centuries created highly fertile alluvial soils on the flood plains which on the one hand can sustain high levels of biodiversity and on the other hand have made those areas preferred places of human settlement and agricultural development. Depending on factors such as the geomorphology and connectivity between the river channel and the adjacent flood plain, other beneficial effects may be observed e.g. that fertilizers, salts and pollutants may be washed out of the floodplain soil and groundwater resources can be recharged.

13 An essential but on the policy level frequently neglected consideration in the assessment of land use effects on those fluxes is scale. While some pollution effects, such as pesticides and heavy metals can be traced on larger scales, the relationship between land-use and flow variables becomes increasingly difficult to establish with increasing spatial scale. For example the effects of certain land

cover changes on sediment load and peak flows can be established in smaller watersheds but on basin scales this is scientifically not sufficiently explored territory. On that scales there are no simple cause and effect relationships but the system that influences those parameters on larger scales becomes highly complex. Table illustrates these points by providing an indication of observable impacts of land use on various parameters for different spatial scales. The qualifications provided in later parts of this publication should be read in light of that.

Impact	Basin size [km^2]						
	0.1	1	10	100	1 000	10 000	100 000
Average flow	x	x	x	x	-	-	-
Peak flow	x	x	x	x	-	-	-
Base flow	x	x	x	x	-	-	-
Groundwater recharge	x	x	x	x	-	-	-
Sediment load	x	x	x	x	-	-	-
Nutrients	x	x	x	x	x	-	-
Organic matter	x	x	x	x	-	-	-
Pathogens	x	x	x	-	-	-	-
Salinity	x	x	x	x	x	x	x
Pesticides	x	x	x	x	x	x	x
Heavy metals	x	x	x	x	x	x	x
Thermal regime	x	x	-	-	-	-	-

Legend: x = Obervable impact; - = no observable impact

Table 1: Spatial Dimensions of land use effects (Source: FAO 2000)

2.2 Impacts of land use on flood hazards

14 With increasing human alteration and development of the catchment area, the runoff generation process is changed, especially through decreasing the infiltration capacity of the soil and the change of soil cover.[1] This has lead to concern over the role human alterations of the catchments play in increasing flood hazards. For example, a commonly repeated element of media coverage and political initiatives on floods has been that the large-scale deforestation leads to increased flood hazards. It needs, however, to be born in mind that while this may hold true under certain circumstances, such as in small urbanized catchments, it does not imply that through employing a conservation agenda for certain types of land uses, floods can be prevented, in particular on larger scales. The flood formation process is influenced by various other factors - for large scale floods especially the geomorphology of the catchment area, and preceding rainfall conditions.

15 Hydrological responses to rainfall strongly depend on local characteristics of soil, such as water storage capacity and infiltration rates. The type and density of vegetation cover and land-use characteristics are also important to understand hydrologic response to rainfall. Environmental degradation coupled with uncontrolled urban development in high-risk zones, such as historical inundation plains and at the base of mountain ranges, leads to an increased vulnerability of those communities on the floodplains to catastrophic events.

16 Saturated conditions, or conditions quickly becoming saturated during the rainfall event, inhibit infiltration of rainwater. The consequences are most abrupt for high-intensity rainfall over

[1] Another source of flood hazards stems from high tides and storm surges along the worlds coast lines. While the focus of this publication has been placed on flood hazards from riverine and urban flooding, it has been attempted to make a number of linkages to the specific case of coastal flooding and planning issues in the coastal zone. In delta regions the issues of riverine and coastal flooding merge into another specific case.

small, steep basins. The hydrology of these catchments is determined by physical factors such as orography, geology, and vegetation cover.

2.2.1 Effect of specific development intervention on flood hazards

Large scale diversions/ earthworks

17 Large-scale earthworks within the floodplain, particularly the active share of it, can result in obstructions to flood flows. Such earthworks can be undertaken as part of developing new infrastructure, industrial and residential areas. For water resources development barrages or dams may be constructed in the upper reaches of a water course. Depending on the topography of the area this in case leads to the diversion of water into a neighbouring catchment and may increase the flood hazard there.

Construction of transport infrastructure and cross drainage works

18 The development of transport infrastructure such as highways and railroads ideally requires flat and open corridors of stable land. Such conditions can be found on floodplains and in various parts of the world floodplains are used to develop such infrastructure. Those roads are usually elevated above the adjacent land to minimize risk from flooding to the transport system. Under flood conditions those works can serve as embankments, i.e. an obstruction to the water. In case this may be desirable and intended, however, if they are located without consideration to the prevailing flood flow conditions they may increase flood hazards on the adjacent land. If such work is aligned parallel to flood flows and too close to the river channel, it may cut off a substantial part of the floodplain and therefore reduce the conveyance or storage capacity of the river under flood conditions. This can lead to increased flood hazards both upstream and downstream of such artificial 'bottleneck'.

19 Similarly, if an elevated road traverses a floodplain it can substantially obstruct the flow of floodwaters. Depending on the size of the river and expected flood flows usually bridges or culverts are constructed to traverse the river channel and the immediately adjacent floodplain. However, construction cost considerations usually prohibit to extend bridges or culverts to cover a wider stretch of the floodplain traverse. This particularly becomes a problem where parallel river channels form during flood conditions that have not been accounted for in the design of such cross drainage works.

Flood embankments

20 The above described bottleneck effect can also be observed with flood embankments that do not leave sufficient space to the water course to safely convey flood flows. This counts for ring levees around cities, industry parks but also for agricultural levees along water course. In particular the latter ones affect rather large shares of the floodplain that are under natural conditions available as flood water storage areas. When planning embankments a view will need to be taken not only on the benefits it may create for the directly protected areas, but also what happens beyond the spatial scope of such intervention. Are the upstream areas prepared to deal with backwater effects? Are the downstream areas prepared to convey or store parts of the enhanced flood flows? Are opposing banks of the river prepared with the same safety standards in case they are under different jurisdiction?

2.2.2 Effect of land use change processes on flood hazards

21 As civilization progresses, human activities gradually encroach on the natural environment, altering the dynamic equilibrium of the hydrologic cycle and initiating new processes during rainfall events. It is now well accepted that there exists causal links between environmental degradation, land-use and vulnerability to disaster. In physical terms, for instance, flash floods are considered to be fast onset disasters, but the root cause may reside in a historically progressive process of environmental

degradation and unsustainable land-use that affects the hydrological response and the impact of the flood.

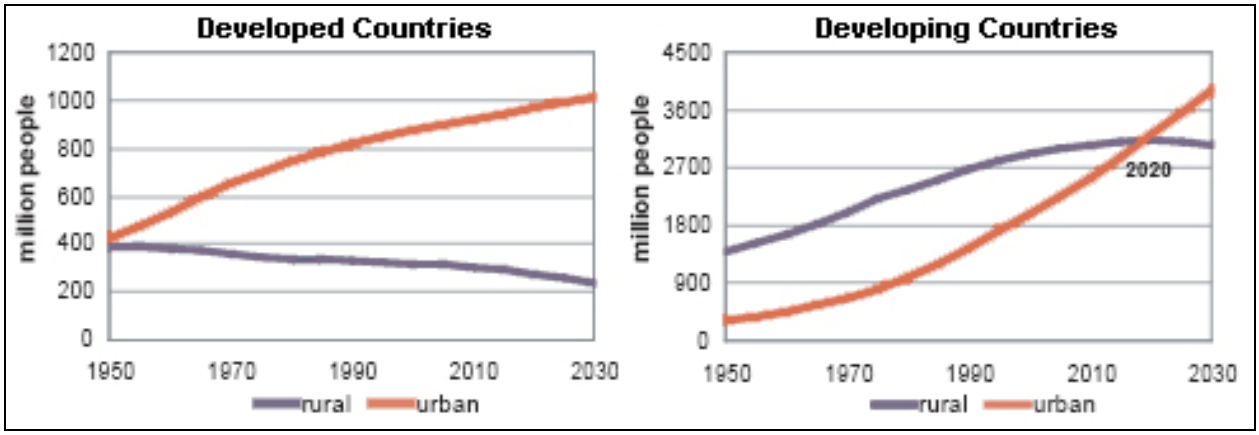
Urbanisation

22 Urbanisation disrupts natural drainage patterns; natural watercourses are destroyed and the natural retention of runoff by plants and soil is removed. By changing pervious natural surfaces to less- or non-pervious artificial surfaces, the storm water runoff rates and the total runoff volumes will increase as a result of a declining natural water storage capacity of the soil. All these factors are leading to an increased risk of urban flooding. Change of natural water storage as a consequence of urbanisation also causes significant changes to the temporal characteristics of runoff from an urbanised area, such as shortening the runoff travel time and giving to the event a flashing appearance.

It is important to better understand the underlying dynamics that lead to the total disregard of natural drainage patterns and watersheds in the process of urbanisation. The extent of current and expected urbanization in terms of total population in urban areas is illustrated for both, developed and developing countries in Figure 2 (Source: EarthTrends, 2008)

Figure

23 Interestingly, it is estimated that around the year 2020, in both developed and developing countries, the total population in urban areas will outnumber the population living in rural areas.



(Source: EarthTrends, 2008)

Figure 2: Population Growth and Urbanization, 1950-2030

Agricultural Practice

24 Agricultural practices also have an influence on the runoff generation process. Various components of agricultural practices can affect the runoff/infiltration process, including the following:

- Soil drainage system: the availability and design of trenches, ditches or pipes in the soil which are utilized to control the soil water content and groundwater levels on agricultural land,
- Soil tillage: especially the compaction of the topsoil and the orientation of the furrow,
- Choice of crops planted and cropping patterns: each crop but also the amount of crop residues available on the soil has on influence on the runoff and erosion process.
- Slope of the field: terraced soils in steeply sloping areas can to a certain extent slow down runoff.

Forest cover type

25 Apart of the general factors such as geology, orography, soil type and preceding rainfall conditions, runoff from forested areas is also influence by the type of forest cover, especially the density of forest, the canopy and the soil cover. Significant changes to those parameters such as excessive logging, conversion of forested areas into other land-use types, conversion of land through forest fires, have an impact on the runoff generation process and erosion processes in particular on smaller spatial scales. [2]

2.3 Impact of land use on flood damage potential

26 Next to land-use induced changes to the characteristics of the flood hazard, the way land resources are utilized has a major influence on the creation of flood damage potential and the creation of vulnerabilities of local communities to the flood hazard.

2.3.1 Flood damage potential

27 The location of economic values on floodplains or the investment into floodplain areas has played a major role in the development history of most countries. Depending on the availability of some level of flood defence, the overall economic output from floodplain areas can be significantly higher than in other areas. This also is evident from the high population densities floodplains have attracted over time. With growing economies and the emergence of wealthier societies, the damage potential from flooding is constantly rising. Flood damage potential can be defined as the extent of possible damage in a given flood hazard area [3]. This means that the benefits derived from the floodplains are provided at a risk, i.e. the risk of having to bear flood damage. This flood damage can come in various forms to buildings, goods, crops, infrastructure, or the environment. [4] By taking decisions on land-use and on placing such values on land liable to flooding humans have an influence on the flood damage potential. Therefore, in modern flood management approaches land-use planning and regulation plays a vital role in controlling the flood damage potential to acceptable levels.

28 In this context it seems important to consider that society through political processes and individual choice has to take decisions on the level of flood risk it is willing to accept. Those choices are sometimes explicitly formulated in form of policy documents, laws or similar instruments. However, in most cases the choice is implicit, e.g. by deciding the location of a particular development, or by providing insurance cover to certain developments in flood-prone areas. It is argued here that those implicit choices are too often taken without awareness of the prevailing flood risks. This is the actual problem that has lead in case to unreasonable increases of damage potential, especially where reasonable and less risk-prone alternatives may have existed. This trend can be observed in various countries, not only confined to developing countries that may lack the means to undertake flood risk assessments.

29 The overall flood management policy should therefore point in a direction where implicit and explicit choices are possible under the awareness of prevailing flood risks and where those risks must be considered in the decision-making process.

30 A feature of popular debate about flood risk is the citation of total flood damage potential in river basins. While employing such statistics to raise the level of flood risk awareness and to point at unreasonable increases in flood risk can be beneficial, they tend to oversimplify the issue if employed as “stand-alone” argument. When using such figures several aspects which are normally not taken into include

[2] An in-depth review of the role forests play in flood hazard mitigation is available from FAO at http://www.fao.org/forestry/webview/media?mediaId=11722&langId=1
[3] See: Loat, R. Meier, E., Dictionary of Flood Protection. Bundesamt für Wasser und Geologie, 2003.
[4] See also: WMO (2007) Conducting Flood Loss Assessments, Flood Management Tools Series. Available at http://www.apfm.info/pdf/ifm_tools/Tools_Flood_Loss_Assessment.pdf

- the benefits that the use of floodplain areas provides to society
- the possible lack of less risk-prone alternatives
- the level of protection that existing flood defences and flood-proofing measures provide

31 It is therefore essential to take a broader view of risk-benefit relationships in devising flood management policy. The prime economic indicator for success of flood management policies should be the net-benefits that are derived from the floodplains, based on an environmentally sound and sustainable approach[5].

2.3.2 Flood vulnerability

32 Apart from the damage potential the degree of vulnerability of various human activities to flooding plays a crucial role in determining overall flood risk. Vulnerability can be defined as degree to which a socio-economic system is susceptible or resilient to the impact of flood hazards. While this definition can also include flood damage, resilience includes the aspect of how well the system is coping and is as such influenced by community's combination of prevailing social conditions and factors such as poverty and livelihoods[6]. For instance, if an emergency shelter or an essential access road is flooded, the structural damage may be negligible compared to the problems this creates for the emergency response, in finding adequate alternatives and in consequence the safety and well-being of the affected population and the speedy recovery process. Or in cases where means of local income generation are disrupted or destroyed by flooding, such closure of as local factories, the recovery process may be much more problematic, far beyond the direct damage to the facility. It is therefore essential to take count of flood vulnerability as part of overall flood risk in land use-planning and regulation.

33 One way of approaching this is through flood vulnerability classifications of different types of developments and uses. Each class of developments can be regulated differently under the principle that the higher the vulnerability of the development or use, and the consequential impact on socio-economic activities of the society, the lower should be the flood hazard in the area where it is placed. If this is not possible, measures should be taken to reduce the damage potential (through flood proofing or local flood defences) or the vulnerability of the affected population. The latter would for example relate to mandatory provision of evacuation plans or emergency response plans to such developments. Some elements may be classified differently in different socio-economic conditions, for example, in an area based on subsistence agriculture, where destroyed crops would present a major blow to food security.

[5] Compare: APFM, 2006: Environmental Aspects of Integrated Flood Management. Available at http://www.apfm.info/pdf/ifm_environmental_aspects.pdf

[6] Compare: APFM, 2006: Social Aspects and Stakeholder Participation in Integrated Flood Management. Available at http://www.apfm.info/pdf/ifm_social_aspects.pdf

3. LAND USE PLANNING AND FLOOD MANAGEMENT

34 The need for a closer integration or coordination between flood management plans and land use plans has been recognized since long. However, many countries are struggling to devise appropriate policies and administrative mechanisms that would facilitate such integration. Fundamental characteristics and the aims of those planning processes and policies have been driven and implemented by different stakeholders and decision-makers. Therefore it is required to seek a mutual understanding of those two processes.

3.1 Visiting terminology

3.1.1 Land use Planning

35 The field of public policy that is referred to as "Land use planning" in this paper has various corresponding terms which are sometimes used interchangeably. Some of these are:

- Regional planning,
- Town and country planning,
- Urban planning, or
- Spatial planning.

36 Depending on the country and the context where the term is used the meaning of the term varies. The overarching theme in all those terms, however, refers to ensuring that land is used in the most efficient way to serve society in achieving its economic, social and environmental goals. Usually this is undertaken in an environment of competing uses. As such land use planning is a balancing act. With a reference to flood management that balancing act can be centrally illustrated in the ongoing debate characterized by the two paradigms "space for development" and "space for water/rivers". The operational instrument to guide this process are land use plans.

3.1.2 Flood Management

37 Similarly, various terms are used with reference to "flood management". They differ in concept depending on the country where they are used and the overall aim that is given to flood management policy. For example, in some countries the term "flood management" is synonymously used with "flood control", emphasizing the control approach with connected focus on river engineering and structural flood management measures. While those structural measures also form part of flood management, the control approach is slowly loosing the central stage as policy paradigm. Societies increasingly recognize that floods can only be controlled to a limited extent and that absolute safety from flooding is a myth.

38 A sustainable development perspective has been brought into the flood management domain in recent years leading to terms such as:

- Integrated Flood Management
- Sustainable or Holistic Flood Management
- Flood Risk Management

39 These approaches differ in subtle emphasis that is placed on the aims and objectives of flood management, depending on the on the social and economic background of the area. For example, Integrated Flood Management explicitly aims at maximizing the efficient use of floodplains while minimizing losses of life from flooding (APFM, 2004). Flood risk management, while not having a uniform definition in literature, lays emphasis on reducing the overall flood risk. In all these

approaches recognition is given to the above described interactions between the land and water environment.

40 Taking wider view on the interactions between the land and water environment within a river basin, and on the wider socio-economic and environmental implications of floods, Integrated Flood Management approaches form a good conceptual basis to bring about a convergence between the land use planning process and the flood management process.

3.2 Planning processes

3.2.1 Land use planning processes

41 *Land use planning processes* take place on various levels of Government, usually with increasing levels of detail with decreasing administrative scale:

- At the highest administrative levels such as federal or national level in form of land use policy or (strategic) plans that specify general aims, objectives and measures for future land use that are binding for all development authorities concerned.
- At the state, district or similar level in form of plans specifying development ambitions and required land uses under its jurisdiction.
- At the local or municipal level in form of local land use plans with detailed allocations of particular land parcels to specific uses or specific planning application procedures to be followed for different zones.

42 On the local level those may be prepared as "comprehensive plans"[7] to layout strategies to manage land development in a community. Those plans are usually binding for the land owners or developers concerned. Such comprehensive local development plans are for instance used in various parts of the United States. Even though varying in emphasis in different locations such plans would usually contain elements on community infrastructure (schools, hospitals, civil defence, etc.) and transportation, housing and neighbourhood development, cultural heritage, environmental assets and conservation sites, and economic development. They do have sometimes a specific component on flood hazards and risks. An example of a land-use planning map illustrating the distinctions of various land uses made is provided in the Annex.

3.2.2 Flood management planning processes

43 Similarly flood management plans are developed at different levels as part of sectoral planning. These include:

- Basin or Catchment Flood Management Strategy
- Basin or Catchment Flood Management Plan[8]
- Local Floodplain Management Plan
- Project Plan

44 The different plans largely vary on spatial and temporal scales. The first two are prepared for comparably large areas and partly with substantial time horizons (reaching up to several decades). The latter two types of flood management plans are prepared on rather small spatial scales and time scales of months or a few years. Stand-alone local floodplain management plans for a particular (relatively small scale) stretch along the river or all the floodplains under the local government's jurisdiction, are prepared, particularly in communities regularly affected by flooding. In those plans a variety of specific issues can be addressed such as flood hazard mapping needs, regulatory standards and

[7] Burby, R.J. : Land-use planning for flood hazard reduction – The United States Experiences, in Parker (ed.) (2000) Floods, Volume II, Routledge, London

[8] See also: WMO (2007): Formulating a basin flood management plan, Flood Management Tools Series. Available at http://www.apfm.info/pdf/ifm_tools/Tools_Basin_Flood_Management_Plan.pdf

procedures, areas where repeated flood losses have occurred, areas which should be acquired by the public and cleared, local flood defence requirements, river bed corrections and adjustments, etc.

3.2.3 Other related planning processes

45 Depending on the stage of development in a society and its political priorities, various other sectoral development plans may be of interest in flood management due to their relation to flood risks:

- *Industrial Development*: Flood risk consideration in planning industrial developments is essential to provide sustainability to business operation and to control flood damages potential. These also address control of pollution and spread of hazardous substances due to flooding of industrial premises.
- *Agriculture Development/ Poverty Reduction:* heavily relies on floodplain areas du to the readily available fertile soil and water resources. At the same time agricultural practices can influence runoff generation, infiltration processes and sediment yield.
- *Water Resources Management:* flood risks form a central component of water resources management plans to ensure the effective use of flood waters and safeguard the functioning of the water system during floods.
- *Transport and Communication Development:* location and structural design of those infrastructure elements need to be planned in full awareness of flood hazard areas and the possibility of hampering infrastructure impacting on the hydrological processes and flood magnitudes.
- *Disaster Management:* is undertaken with a view to all hazards affecting communities, including flooding.

46 The complex inter-relation between various development processes to land-use planning and flood management is illustrated by an example from England in Figure 3. A feature apparent from this example is the obvious disparity between plans prepared for certain jurisdictions such as the municipal or national level and those developed for catchments and river basins (CFMP=Catchment Flood Management Plans).

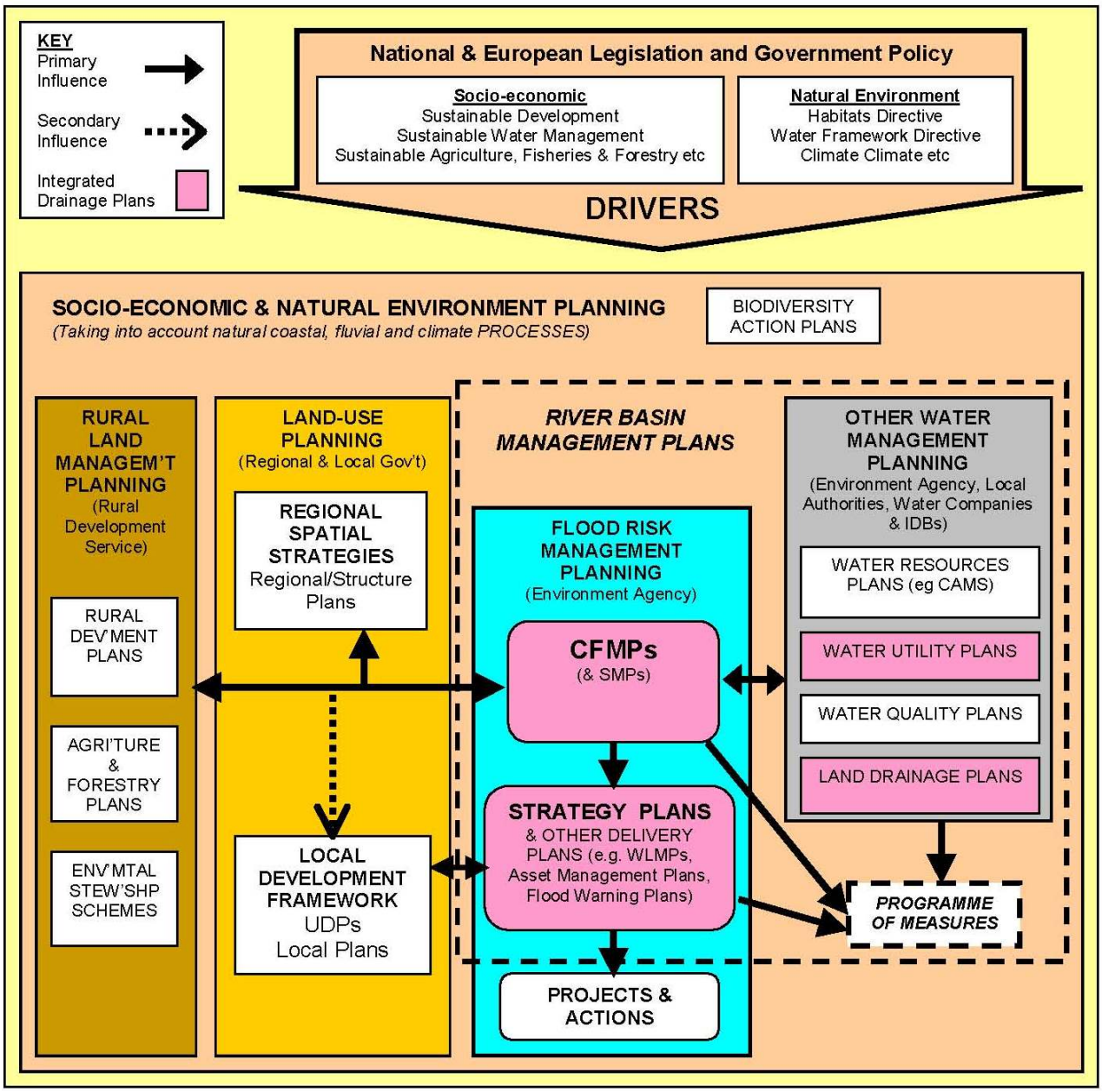
3.3 Roles of land use planning in flood management strategies

47 It needs to be stressed that only a best mix of the strategies presented in Table 2 adjusted to the particular circumstances of each river basin can serve the aims of Integrated Flood Management. This becomes apparent when thinking of a flood management strategy that would only focus on reducing the susceptibility to damage as this would lead in its most consequent form to largely ignoring the development potential of the floodplains.

Table 2: Strategies and Options for Flood Management (WMO, 2004)

Strategy	***Options***
Reducing Flooding	Dams and reservoirs
	Dikes, levees, and flood embankments
	High flow diversions
	Catchment management
	Channel improvements
Reducing Susceptibility to Damage	Flood plain regulation
	Development and redevelopment policies
	Design and location of facilities
	Housing and building codes
	Flood-proofing
	Flood forecasting and warning
Mitigating the Impacts of Flooding	Information and education

Strategy	*Options*
Preserving the Natural Resources of Flood Plains	Disaster preparedness Post flood recovery Flood insurance Flood plain zoning and regulation



(Source: Environment Agency, 2004)

Figure 3: Links between flood risk management plans and wider planning framework in England

48 Taking a closer look at the strategies and options for flood management it becomes apparent that land use planning plays a central role in three out of four of them, which in the following is elaborated further.

3.3.1 Reducing Flooding

49 All structural flood management interventions need to be incorporated into the land use planning process to safeguard spatial requirements of those measures now and in the future. This proves in practice a challenging task as spatial requirements can be substantial with limited available land resources e.g. for a dam or reservoir but similarly for levees and diversion channels. Further our knowledge of the future is inherently limited. This particularly concerns future economic drivers, as well as future rainfall patterns and other climatic factors which form the basis of planning the location and spatial requirements of hydraulic works in general and structural flood management measures in particular.

50 Another option under this strategy summarized under “Catchment Management” refers to measures taken over the whole catchment area (not only the water system) to optimize the functioning of the catchment, in this instance for flood management. This can entail a source control approach that seeks to keep as much rainwater retained where it falls so flood peaks can be attenuated. Another consideration taken in Catchment Management refers to where flooding causes least harm - and where it should occur - to protect other crucial areas such as cities and industrial centres with high potential for damage. Those high risk areas need to be identified and made part of the land-use planning and regulation process, in order to be kept free from high risk uses.

3.3.2 Reducing Susceptibility to Damage

51 This strategy has one of the strongest relations to land use planning and regulation. A basic requirement is the availability of flood hazard maps that indicate the areas exposed to flooding for flood events of a given return period. Based on those maps different flood hazard zones can be delineated and placed under land-use regulation to limit the flood damage potential in those areas. Those regulations are tools to prescribe what uses are possible and under which conditions. Such conditions can also be put in place in terms of building regulations and codes. Further they can be used to prescribe adjustments to existing developments in those areas, e.g. flood proofing or relocation of existing developments.

3.3.3 Preserving the Natural Resources of Flood Plains

52 Floodplains are subject to competing uses. Societies have an interest to make use of their vast natural resources which in certain cases leads to an overexploitation in form of converting large parts of natural habitats on flood plains into other land-forms with known repercussion not only for biodiversity and the functioning of floodplain and riverine ecosystems but also for associated livelihoods and the economy. Land use planning and regulation plays a key role in balancing the development requirements and the preservation of the natural resources on flood plains.

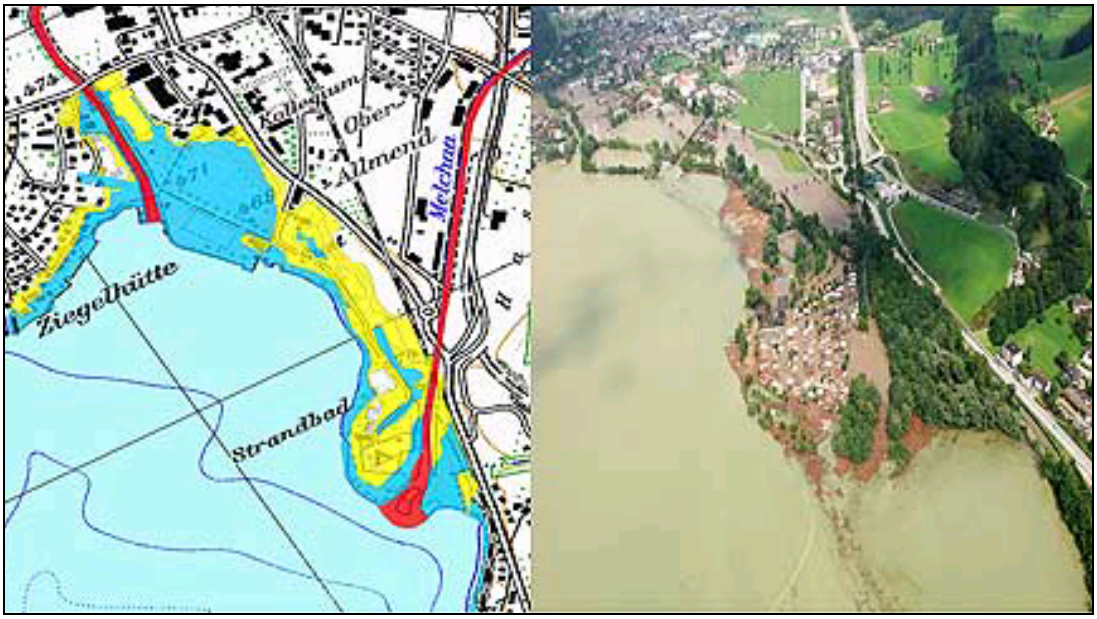
3.4 Tools and mechanisms for interaction

53 Interactions between those planning processes can take place at various levels and through a number of instruments, which are subsequently discussed. It needs to be noted that the application of those instruments depends on the place flood risks have on the prevailing political agenda. Generally, development planning plays politically a much more important role and the local and regional development agencies usually hold far more powers over development than dedicated flood management agencies. Examples do also exist where river basin authorities are mandated to formulate and execute development plans or flood risk management plans, but those cases are rather the

exception than the rule[9]. Only after exceptionally large floods or after flood disasters, flood management issues acquire (temporarily) importance on the political agenda.

3.4.1 Flood hazard maps

54 Provided by a qualified scientific technical institution on appropriate scales, flood hazard maps are the central instrument to facilitate interaction between different sectoral planning agencies. Obligations can be placed on those agencies that they must consult those maps or the agency that provide them in taking planning decisions.



(Source: Swiss Federal Office for the Environment/Schweizer Luftwaffe)

Figure 4: Comparison between a flood hazard map and a flood situation during the 2005 floods in Sarnen, Switzerland

3.4.2 Flood risk assessment of strategies and plans

55 Strategic plans in particular on higher administrative levels and outside the flood management domain can be placed under flood risk assessment procedures. This would help to gauge in advance the likely impact of a particular plan or strategy.

3.4.3 Flood risk assessment for particular planning applications

56 Obligations can be placed on developers of particular land parcels in flood hazard areas to provide flood risk assessments as part of planning applications together with required flood risk reduction measures.

3.4.4 Environmental Assessment

57 Two environmental assessment procedures applied for various instances can also incorporate elements of flood risk. One is Strategic Environmental Assessment conducted for plans and

[9] Compare the case of the Tennessee Valley Authority, especially the Act creating the Authority. Available at http://www.tva.com/abouttva/pdf/TVA_Act.pdf

programmes with likely significant effects on the environment and the other is Environmental Impact Assessment applied on project scales.[10]

58 In assessing the level of opportunity that could arise from interaction of planning processes it is important to bear in mind that a dedicated sectoral authority, e.g. a floodplain management authority, has a clear sectoral focus and associated objectives to pursue such as protecting life and property on the floodplains and the sustainable use and management of floodplain resources. A very different picture arises when considering the multiple objectives local authorities have to pursue, such as public service provision (health care, transport and mobility, security, education, water supply, electricity, etc.), employment generation, local economic growth, creating a safe and attractive community life, etc. Through this multi-objective planning requirement, the hazard consideration will be one of many considerations taken in preparing local land use plans.

59 Another consideration is required about the local constraints in terms of financial means, limited jurisdiction and technical expertise available at the local level. Local economic growth and development is one key to develop the supply side of finances available to local government. The return received from activities in these areas is usually perceived as direct while investments in hazard mitigation of whatever kind may be perceived as less visible, potentially slowing immediate growth targets in particular when employing land-use regulations and therefore secondary priority to local decision making.

60 In view of this a collaborative approach between sectoral planning agencies, specialized technical agencies and local governments is required that would seek to complement each others jurisdictional, technical and financial means in maximizing the efficient use of floodplain resources.

BOX 2: Principles for Spatial Planning and Natural Hazards in Switzerland

While different countries may have developed a specific and detailed approach for devising the appropriate role of land-use planning in flood management, a number of central policy elements are derived here from the example provided by Switzerland. Those are built on fou pillars name to recognize hazards, to avoid hazards where possible, to cope with the risks and to review safety regularly.

Switzerland has to deal with scarce land resources, affected by multiple hazards, combined with a strong and diverse economy that has made use of the floodplains for centuries. On the other hand, Switzerland has already gained substantive experience with employing land use planning as a tool to deal with flood hazards and risks on the technical as well as legislative and regulatory frontier.

For detailed description of the approach see: Recommendation of the Swiss Government on “Spatial Planning and Natural Hazards”. Available at
http://www.bafu.admin.ch/php/modules/shop/files/pdf/phpQGDOdh.pdf

[10] For a detailed description on the application of those two procedures see: Environmentally sensitive flood management decision-making framework. In: APFM, 2006: Environmental Aspects of Integrated Flood Management. Available at http://www.apfm.info/pdf/ifm_environmental_aspects.pdf

4. DEVELOPMENT MANAGEMENT TECHNIQUES IN THE FLOOD HAZARD CONTEXT

4.1 Paths of Government intervention

61 To *implement* a land use plan Governmental action can use various means. The first and perhaps most applied is land-use regulation which in practice is usually combined with other means such as the provision of incentives, knowledge enhancement and redirecting or rearranging public investment. The typology provided in Table illustrates those means in more detail with a particular view to the flood hazard context.

Table 3: Typology of development management techniques in the flood hazard context

Mitigation targets	Strategy of government action			
	Regulation	**Incentive**	**Knowledge enhancement**	**Public investment**
Land use	• Prohibited development • Limit density • Exclude hazardous/critical land uses	• Density transfer/density bonus • Preferential taxation	• Public awareness campaign	• Locate public facilities outside floodplain • Purchase property
Design of building site/Landscape design	• Elevate site with fill • Elevate roads and other infrastructure • Set back from hazard • Cluster on least hazardous portion • Impervious surface regulations • On-site flood detention/retention requirements • Impact assessment	• Availability of flood insurance	• Technical assistance publications • Workshops for site planners/civil engineers • Technical assistance of retrofitting provided at disaster assistance centres after floods	
Design of buildings	• Elevation to or above base flood (e.g. 100-year flood) • Flood-proofing • Retrofits of existing buildings • Impact assessment	• Availability of flood insurance • Low-interest loans • Tax deferral	• Technical assistance publications • Workshops for architects/home builders • Technical assistance on retrofitting (see above)	• Design public buildings as leading by example
Knowledge of hazard/mitigation	• Mandatory disclosure in real estate transactions • Mandatory delineation of floodplain areas • Mandatory requirement of flood insurance	• Free or low-cost technical assistance	• Public awareness campaigns • Flood warning system • Posting of warning signs • Provision of information in public libraries • Participatory planning processes	

Area-wide control of flood hazard	• Peak discharge standards • Storm drainage requirements • Impact fees for flood control		• Flood control structures • Channel improvements • Watershed treatment
Resilience of public facilities	• Subdivision design standards	• Vulnerability assessment	• Design standards on public buildings • Retrofits

Adapted from: Burby, R.J., Land-use Planning for Flood Hazard Reduction, in: Parker, D.J. (ed.), Floods (2000).

62 For instance, regulating land-use could imply that only open space land uses would be possible in high risk areas. Regulating developments would imply that certain adaptations would be required to building design and other features of the development.

63 The detailed selection of means to be utilized will depend on the local context in terms of the prevailing socio-economic, legal, political and cultural conditions, however, a mixture of elements from above-mentioned strategies is more likely to be successful than only focusing on one of the columns[11]. For example, regulations brought forward by Government that prohibit to develop a particular floodplain may collide with local economic or private land owner interests if not combined with a public awareness campaign on the risks of development in that area, and the provision of reasonable alternative options to pursue local development aspirations. As described in Chapter 2 one of the key considerations would be how much land is required to pursue a local development agenda and how much of it is located in hazardous areas. This usually limits the choices considerably.

64 Enforcement capacity of the authorities concerned has an impact on the choice of instruments applied. Enforcing land-use regulations can be a lengthy, complex and resource intensive task. Depending on the prevailing system of property rights regulations can be challenged on various grounds in courts and this can hamper implementation considerably or even deny the achievement of the initial intent of the regulation on legal grounds[12]. This is another argument why authorities have applied combined instruments to exert control over land-use. The National Flood Insurance Programme (NFIP) in the United States is a federal program enabling property owners in participating communities to purchase insurance as protection against flood losses in exchange for State and community floodplain regulations that are designed to reduce future flood damages[13]. Other incentives mentioned in Table include taxes and fees as a tool in land use regulation. Various models of taxation and fees on land and developments are also applied to provide incentives to preferential land uses and development options, or provide disincentive to undesirable uses (i.e. in the context of this paper high flood risk).[14]

65 Another key determinant of the approach selected will be driven by how many assets and how much investment has already been taking place in floodplain areas and to work towards floods risk reduction in those areas. In this context it needs to be noted that land-use and development regulation may locally be perceived as unreasonable or inequitable and means taking or devaluation of property.

[11] Compare : Burby, R.J., Land-use Planning for Flood Hazard Reduction, in: Parker, D.J. (ed.), Floods (2000).

[12] Various court cases in the US on land use regulation are referred in a concise format in: Wright, R.R. and Gitelman, M.: Land use in a nutshell, 4th Edition, West Group, 2000

[13] See: Federal Emergency Management Agency, Federal Insurance and Mitigation Administration: National Flood Insurance Program – Program Description, 2002 available at http://www.fema.gov/library/viewRecord.do?id=1480

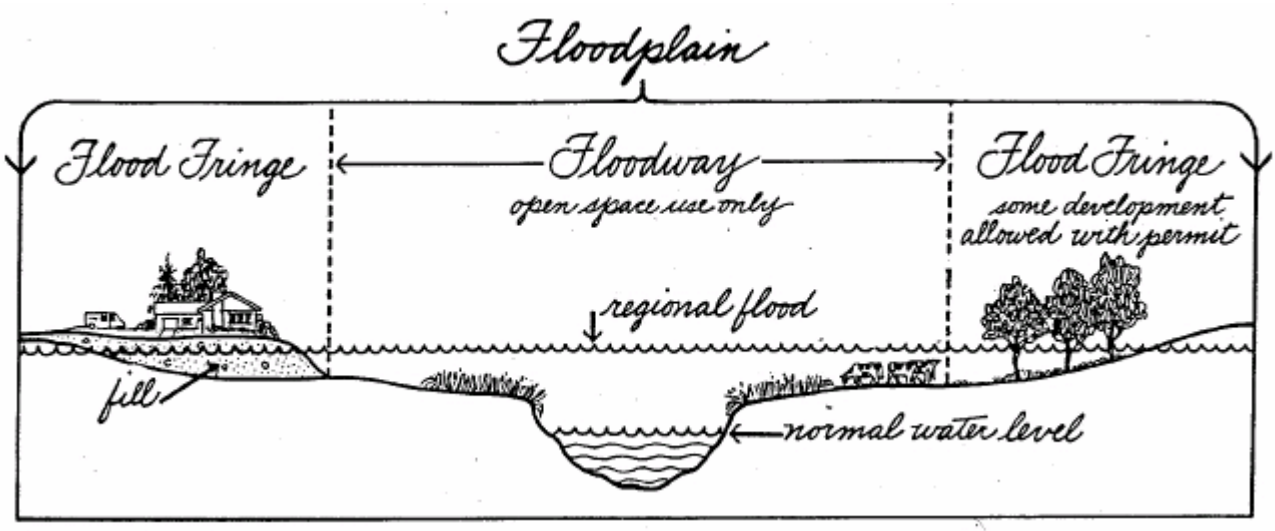
[14] For detailed analysis of the application of fees and taxes as means of land-use control see: Anderson, J.A., 2005

Various court cases have highlighted such issues[15]. Based on the system of individual rights versus the rights and powers of the State, courts will resolve such disputes.

66 Looking at the social structure of communities it becomes apparent that in the process of urban growth land subject to flooding is increasingly used with higher risk uses. The parts of the floodplain regularly affected by flooding is in many countries used by the economically weaker sections of society, because land is under less competition in those areas resulting in lower land prices. The imminent risks of poverty in those areas have a much stronger effect on the decision making process of the dwellers than the potential risks from flooding. Authorities may not encourage those dwellers by providing flood defences for such areas as they may have been erected with disregard to prevailing regulations. Where such development has taken place the issue cannot be resolved solely by (re-)instating a regulatory regime that would ban or remove such floodplain dwellings. Policy makers and regulators are aware of the risk that this may lead to social exclusion and an aggravation of poverty. This is particularly relevant where no alternative sites are available for housing, or if other potential areas are exposed to other hazards. In urban context, social housing programmes need to accompany the regulatory process.

4.2 Floodplain zoning and risk sensitive approach

67 It is of crucial importance to adopt a risk-sensitive approach that would increase regulative intervention with increasing levels of risk, based on different hazard zones and the projected or existing types of development within each zone. Compared to the simplicity of that statement in theory, the successful practical application is highly complex.



(Source: Wisconsin Department of Natural Resources)

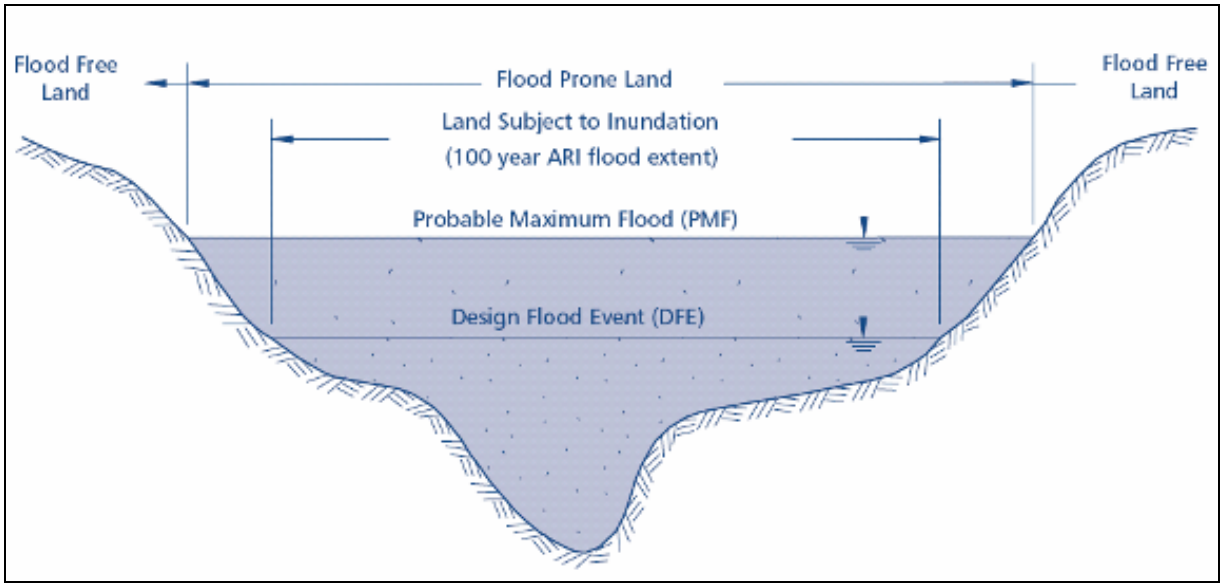
Figure 5: Example of different zones on the floodplain

68 Floodplain zoning ordinances constitute an important tool to operationalize a risk-sensitive approach. Floodplain zoning can be undertaken on the basis of floods of different average annual exceedance probabilities[16]. The most commonly used for land-use planning purposes is the 1% average annual exceedance probability. In the United States, for instance, a further distinction in floodplain zoning ordinances is made between the 'floodway' and the 'floodfringe' based on floods of a 1% exceedance probability. As illustrated in Figure 5, the floodway in this context is referring to the high-risk area that is kept free from any development to allow floodwater pass through this corridor

[15] Compare: Wright, R.R. and Gitelman, M.: Land use in a nutshell, 4th Edition, West Group, 2000
[16] Such as the 1% ("100-year flood"), 0.5% ("200-year flood") or 0,1% ("1000-year flood") exceedance probability.

unobstructed. The level of risk to determine floodway areas can be based on factors such as the depth and velocity of flood water, duration of flooding, available flood storage capacity, or the rate of rise of flood water. While in some countries land-use plans have legal authority in their own right, floodplain zoning ordinances or similar legally binding instruments are used elsewhere to enforce land-use planning.

69 Illustrated in Figure 6, another distinction applied in zoning is made based on the "Probable Maximum Flood (PMF)", which is the largest flood that could conceivably occur in a particular location. This can be based on historical records and specific flood studies. While it is neither practical nor economically viable to provide defences up to that level or to regulate the use on all flood prone land associated with the PMF, it is essential to consider the PMF in locating strategic installations, or for emergency response and evacuation planning.



(Source: Victoria Department of Infrastructure, 2000)

Figure 6: Defining Flood Prone Land

70 Different zones can also be identified based on the type of flooding, such as riverine (or fluvial) flooding, coastal flooding, flash flooding or storm water flooding, and groundwater flooding. While the riverine and flash flooding are relevant for rural and urban areas, storm water flooding is particularly associated to urban areas where overland flow develops from heavy precipitation when the discharge capacity of the storm water drainage system is exceeded.

71 Based on those zones specific regulatory mechanisms can be introduced. High risk areas can be put under strict provisions that regulate land-use and/or developments (buildings, infrastructure, etc). Rules relating to "no development" or even removal of existing developments can be introduced, especially after flood damage has occurred and the cost and sustainability of reconstruction in the particular area is considered undesirable. The latter is usually politically viewed as controversial as the social and legal repercussions of such intervention are difficult to gage in advance.

72 While the development of more restrictive land use regulations can be regularly observed after the occurrence of large flood events, it should not be assumed that regulations must always become tighter. If development options are evaluated in conjunction with flood risk, floodplain regulations may also allow more flexible approaches[17].

[17] Compare for example: Stephenson, D., 2002, *Integrated flood plain management strategy for the Vaal.* In: Urban Water 4 (2002) 425 – 430.

4.3 Planning permits

73 *The process of issuing development or planning permits* is applied to ensure compliance of planned developments or changes of land use with the regulatory regime, i.e. in relation to flood management to limit or minimize the flood risk to the development and the effects of new developments on flood risk elsewhere. Various activities on the floodplain or activities that have an influence on flood risk can be subject to permission, such as:

- Changes of land-use type or intensification of land use
- Buildings and structural works: dwellings, commercial and industrial buildings, levees, fences, roads, embankments, etc
- Earthworks, resulting in: land forming, lanes, tracks, aqueducts, laser grading, surface and subsurface drains, etc
- Subdivision: the splitting of an existing land parcel into several pieces owned by different owners

74 Depending on the type of activity the use of low risk areas such as the 'flood fringe' may be acceptable under certain conditions and enforced during the application process for a planning permit. Certain developments may be permitted under certain conditions, relating for example to the:

- Location and extent of building and works;
- Incorporation of various flood proofing measures into the design of the development;
- Restriction on storage and goods and materials that may create pollution or become a floating hazard during floods;
- Land drainage and effluent disposal requirements;
- Requirements for access roads or tracks;
- Maximum height and extent of landfill and earthworks, including levees;
- Availability of emergency preparedness plans (for example for tourist sites, camping places, hotels etc.); and
- Provision of adequate water retention or drainage facilities.

BOX 3 Tools for Regional Planning: England

75 In England, flood zones have been defined and through a planning policy document next to general policy principles and objectives, several tools are provided for regional planning bodies and local planning authorities to steer development towards zones with lower probability of flooding. Those tools include a 'sequential test' to determine the suitability of land for development in areas liable to flooding, and an 'exception test' which provides a method of managing flood risk while still allowing necessary development to occur. The latter may only be applied under specific conditions outlined in the policy document. Interestingly, the zoning does not take into account flood defences with the argument that those may be breached, overtopped or that the lifetime of developments on the floodplain may longer than the one of the flood defence.

See: Planning Policy Statement 25: Development and flood risk
http://www.communities.gov.uk/documents/planningandbuilding/pdf/planningpolicystatement25

76

- In developed areas protected by levees a strip behind the levee must be kept free of development. This is necessary to allow access in case of flood fighting or maintenance, but also in light of future levee heightening such strip will be required. The question arising in practice is of course how much of the protected area can be kept free of use without harming the economic viability of the protection project.
- Zones where land-use changes can significantly increase flood risk downstream can also be regulated to strengthen retention. This in turn requires an elaborate assessment of flood risk, not only of the areas at risk of being flooded but also of those areas that generate higher peak flows through land use changes.

Table 4: Planning response to sequential characterization of flood risk in France

Regulated flood zone	Appropriate planning response-PPR regulation
White zone of the PPR[18] [Insignificant (*négligeable*) or low risk areas	No constraints
Depth of flooding < 0.50 cm. Low to medium flow velocities	Some alternative urban flood control techniques can be implemented to limit urban runoff or landslides (e.g. land drainage, retention basins)
Blue zone of the PPR [Low to medium risk areas]	Suitable for most development
Depth of flooding < 0.50 cm and fast flowing	For this and higher risk-zones, the regulation principle is 'not to urbanize exposed areas'. It must be strictly applied when buildings have an impact on natural values in floodplains or make risks worse in the whole floodplain storage areas (*l'ensemble du champ d'expansion des crues*), even if the risk is low
0.50 cm < Depth of flooding < 1.0 m and medium flowing	If other development solutions are not possible, most development is suitable with prescribed modification to land use and to existing and future buildings belonging to public and private owners (flood resistant construction, evacuation systems, etc.)
Urban centres in high risk areas	No directly exposed areas (e.g. plateaux and valley sides) can also be regulated when some development or building may make worse the risk downstream, in the valley. They must be included into blue or red PPR zones.
Developed areas with defences	In developed areas with defences such as dikes, it is necessary to maintain a strip behind them where building is prohibited (its width depending on local conditions)
No directly exposed areas (worsening risk zones)	
Red zone of the PPR [High risk areas]	Most development forbidden.
Depth of flooding > 1.0 m and fast to very fast flowing waters	However, the wide bans on development (*l'étendue des interdictions*) can be discussed and varied according to local situations
Annual probability of flooding: 1% or greater	a) In existing urban centres: these may be

[18] PPR stands for «plan de prévention des risques naturels prévisibles » or « Plan for the Prevention of Predictable Natural Hazards »

(rivers)	suitable for development provided there are local flood prevention, protection and safe guarding measures
Floodplain storage even with low risk and even with defences Not directly exposed areas (worsening flood risk generating zones)	b) In areas where the risk may be totally controlled previous to the development c) For land uses compatible with risk (especially agricultural or forestry activities, sports grounds and water recreation areas) d) For developing essential transport and utilities infrastructures that must be located there e) In flash flood areas, where bans are less easily debatable. For example, reconstructing a building destroyed by a flash flood is forbidden, as are new camping sites and other facilities open to the public. For those already existing, flood warnings/evacuation procedures and other conditions may be required (e.g. seasonal opening) depending on the PPR

(Source: Pottier,N. et. al., Land use and flood protection: contrasting approaches and outcomes in France and in England and Wales, Applied Geography 25 (2005) 1–27)

4.4 Building standards and codes

77 Building standards and codes can play a strategic role in reduction of potential flood damages. They must, however, be coordinated with floodplain regulations. Building standards can address various structural features of a development to take into account prevailing flood hazards, such as

- Freeboards above base flood elevation for buildings and essential infrastructure (access roads etc.)
- Protection against foundation erosion
- Limit enclosure for parts of the building below the regulatory flood level (e.g. put houses on stilts)
- Orientation of the building to least obstruct flood flows
- Various measures of wet and dry flood proofing (backflow valves, waterproofing measures to opening like windows and doors, elevated electricity features, water proof storage of oil and other hazardous materials etc.)
- Compensation for storage losses due to land fill

78 Building standards and codes tend to be under a stronger local inspection regime than floodplain regulations. Therefore compliance is more likely to be enforced. Therefore, it is advisable to consider building codes as crucial elements of flood damage reduction strategies when reforming the flood management system. Examples exist where reform to building codes has been undertaken through dedicated flood management legislation [19]. Coordination of such legislation must be undertaken at a higher administrative scale, i.e. nationa/federal or state level.

4.5 Multifunctional land use

79 In view of the dilemma faced by land use planners in dealing with flood hazards multi-functional land-uses play an important role. In countries that face the scarcity of land already for decades and for urban planners this concept is already widely applied. It can, however, be observed that the concept is gaining importance even in countries that previously were not using this approach.

[19] See: German Act to improve Preventive Flood Control (2005), available at http://www.bmu.de/files/pdfs/allgemein/application/pdf/hochwasserschutzgesetz_en.pdf

80 Examples of widely applied multi-functional land uses include the use of water storage areas for recreational (non-residential) purposes, such as outdoor sports facilities, parks and nature reserves.

81 Flood adapted housing is also used increasingly, such as floating structures or elevated structures on stilts. In Southeast Asia such approach is common place for long, yet in the countries that had adopted a strict flood defence policy which worked on the premise that flooding could be prevented, such practices had not been prevalent. Similarly, recession agriculture is commonplace in various flood prone developing countries, using the floodplain for agriculture in the flood-free months.

BOX 3: Example of Multi-functional Use in Japan

In countries with severe constraints on land resources such as Japan, 'super levees' are implemented in urban areas that combine the spaces used for flood defence with other urban uses such as residential or office space. Other benefits can be derived from this approach such as the use of those elevated lands for evacuation point during times of disaster, and they are less prone to fail from being overtopped. An illustration is provided in Figure . This example shows that exclusive land-uses become literally impossible in seriously constrained land resource situations. While this is a special example, it is apparent that countries with vast population growth and urbanization trends or delta regions will require such kind of bold and unconventional solutions in the future to balance development needs and flood risks.

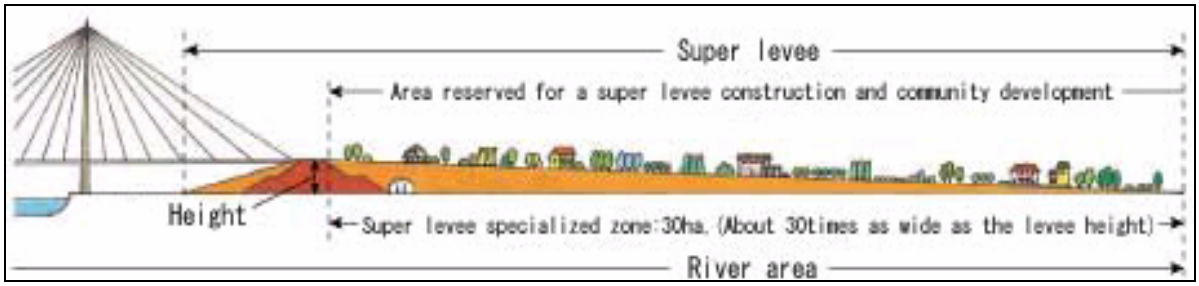


Figure 7: Super levees in Japan

For further information see
http://www2.arajo.ktr.mlit.go.jp/english/how/flood_con/business/super.html and
http://www.jice.or.jp/river/river/rive03.pdf

4.6 Special issues and opportunities

4.6.1 Data availability and uncertainty

82 The zoning approach discussed above needs to be adapted to the local circumstances in particular based on data availability. While in some countries there are sufficiently long data records for precipitation and stream flow for adequately assessing flood frequencies, in many areas such data are either totally missing or the data series are inadequate. In such case alternative approaches will have to be employed. They can for instance be based on the maximum observed floods in living or historic memory, or on the geomorphology of an area.

83 The uncertainty in the available information can also be accounted for in freeboards of developments, such as in the requirements of floor levels. Freeboard is an additional height requirement above the base flood elevation that provides a margin of safety against risks that are

known but difficult or costly to identify[20]. Such risks include uncertainties in current modelling and mapping capabilities, future increases of upstream development that influence the flood peak, and backwater effects from ice or log jams.

84 Planners and flood managers alike are increasingly concerned about the effects that climate change may have on local rainfall characteristics and associated discharge rates, as those parameters are key components of flood hazard assessments. Questions on whether annual recurrence intervals for floods will need to be adjusted in view of that are widely asked and efforts are undertaken to downscale global atmospheric circulation models to regional and national scales in order to be in a better position to answer those questions. Some countries have already taken precautionary steps to address the issue in planning policy. In England and Wales, Government has issued 'indicative sensitivity ranges", providing expected ranges of change to peak rainfall intensities and peak river discharges embedded in a guidance document how those should be applied in planning.[21] Owing to the better understanding of sea-level rise binding provisions for design criteria can also be incorporated for coastal defences and land use planning for the coastal flood area.

4.6.2 Adopting multi-hazard management approaches

85 Even if flood hazards are sufficiently well understood and flood mapping programmes have been conducted, uncertainty may persist about the overall hazard picture. In designing mapping programmes it is therefore essential to have to factor all natural hazards and how they affect the particular area subject to mapping programmes. If the country next to riverine flooding is also affected by other natural hazards such as landslides, earthquakes, mudflows, avalanches, or storm surges, land-use and spatial planning decisions must take them into account as well. This is particularly required to avoid instances where safety against one peril is 'bought' at the expense of another. For example,

- if evacuation from coastal areas is undertaken in the wake of a tropical storm to protect from the effects of a storm surge while higher ground areas may be affected by flash flooding due to the heavy rain the storm brings, the intervention may lead to even more serious consequences than could have been expected from the storm surge.
- If development is shifted from floodplain areas to higher ground which may be subject to landslides, mudflows or avalanches much opportunity may have been lost because development cost in those areas may have come at a much higher cost.

86 Therefore, in literature and on the policy level particularly for the disaster management sector, multi-hazard management approaches have been advocated. In practice, however, multi-hazard management techniques have been met with some reluctance because there seems to be little clarity what that approach would imply. In particular the level of integration required at the institutional level in such an approach presents challenges. A recent study on the level of application of such approaches in Europe has concluded that "A multi-hazard assessment as a special task for one co-ordinating sectoral planning organization does not seem to be required for spatial planning. The provision of single hazard information by different sectoral planning authorities combined with a consideration of the possible relationships and interactions between different hazards (risk chains) and possible cumulative effects can be regarded as sufficient for decisions in planning practice […]" (Greiving et.al., 2006).

87 In view of the high level of scientific and technical expertise required to assess different hazards, sectoral approaches to risk assessment will also prevail in future. As the concept of

[20] See: Association of State Floodplain Managers: No Adverse Impact Toolkit (2003) available at http://www.floods.org/NoAdverseImpact/NAI_Toolkit_2003.pdf

[21] See: Flood and Coastal Defence Appraisal Guidance FCDPAG3 Economic Appraisal Supplementary Note to Operating Authorities – Climate Change Impacts October 2006 http://www.defra.gov.uk/environ/fcd/pubs/pagn/climatechangeupdate.pdf

integration is not a value in itself, it should be applied with care. Each end-user group of flood hazard information may have specific product requirements for example concerning the spatial scales etc. but this is an issue that can be addressed on the level of technical guidelines.

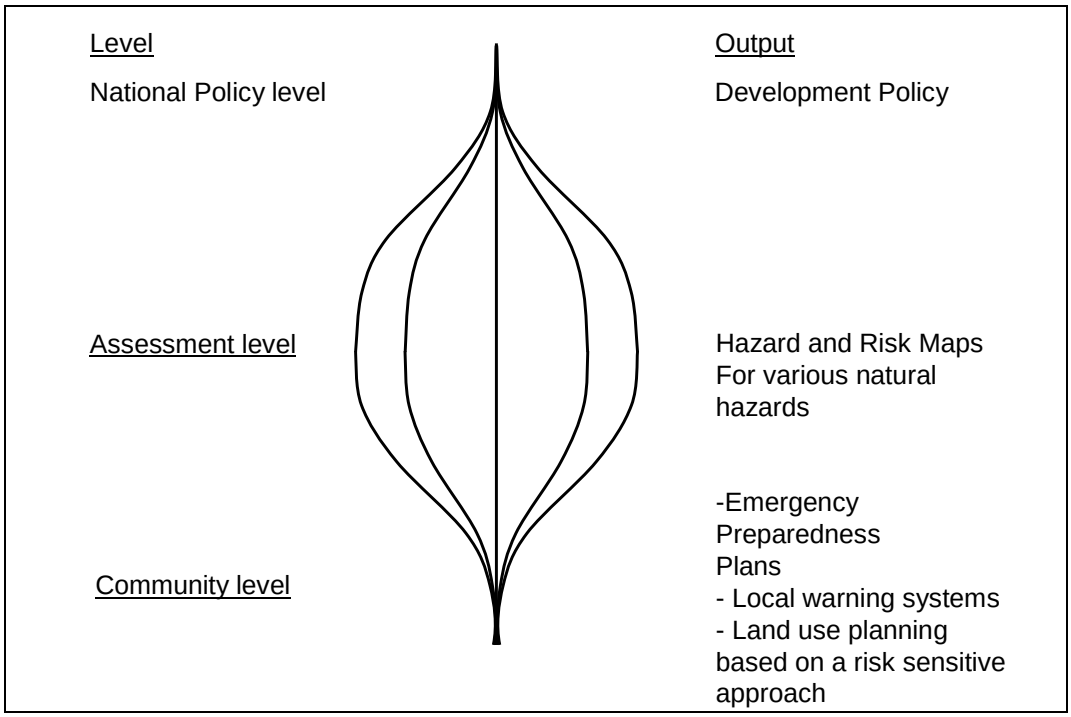


Figure 8: Multi-hazard management framework

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Figure indicates that while on the policy and community levels institutional and conceptual integration must take place, for the assessment of different hazard specialized scientific technical expertise is required which is hard to bundle in one institution. Local or regional land use maps present one essential opportunity to incorporate information on various hazards into the planning process. One country where multi-hazard mapping is currently undertaken is Switzerland with the aim of making such maps available for the entire country by 2011. [22]

4.6.3 Informal development

89 A development visible in various cities around the world is that the initial historic centres have been placed on sufficiently high grounds to be protected from some level of flooding. In the process of urbanization with massive influx of rural populations the spatial requirements for housing become too large to be accommodated in the low risk zones. Even if Governments seek to guide development to less hazardous areas, a variety of reasons lead to informal encroachment of high risk floodplains. Those include:

- Low public awareness of flood hazards and risks and what could be done to manage floods and impacts
- Poverty risk is rated far higher than flood risk by floodplain occupants
- Lacking regulatory framework to restrict development on those areas
- Lacking enforcement capacities of local authorities

[22] See: http://www.bafu.admin.ch/dokumentation/fokus/00117/index.html?lang=de

- Lacking will to enforce regulations either due to lacking alternatives for relocation or lacking funds to provide social housing to floodplain occupants

90 While some of those issues can be addressed in floodplain management programmes (such as raising public awareness) others will need to be based on the collaborative effort of various other sectors, as well as policy and law makers to provide the required institutional framework conditions. Those are discussed in more detail in the following chapter.

5. LEGAL AND INSTITUTIONAL FRAMEWORK

5.1 Rights, Powers and Obligations

Obligation of the State to provide flood hazard or risk maps as the basis of planning

91 The very basis of incorporating flood risk in development planning is the availability of fairly accurate information on flood hazards in form of flood maps. To keep technical and scientific standards harmonized and in view of the highly specialized nature of the subject, it seems reasonable to argue that the preparation of these maps should be coordinated on a higher administrative level, i.e. the river basin or the federal level. Obligations must be placed on relevant agencies to prepare such maps by law backed up with required resources, to make them publicly available and update them in adequate intervals. A recent example is the "EU Directive on the Assessment and Management of Flood Risks" which mandates Member States of the EU among others to prepare flood hazard maps and flood risk maps, at the most appropriate scale.

Provision that natural hazards must be taken into account in the land planning process

92 Once adequate information is made available provisions should be incorporated in the relevant laws and regulations that the hazard information must be taken into account as part of the land use planning process. The (technical) agency responsible for flood mapping should be placed in a position where it needs to be consulted on strategic plans and on specific development planning applications as required[23].

Obligation to disclose hazard information in land transaction

93 Given adequate flood hazard and risk maps are available, sellers of property can be obliged by law to disclose information about prevailing hazards to buyers of the property. Failure to comply can result in legal claims for compensation.

5.2 Clear definition of roles and responsibilities

94 The roles which the different actors take in planning and flood management largely vary from country to country, between sectors, administrative scales and the private public domain. In one country provision for flood defences may exclusively rest with regional catchment authorities or similar body, while in others those responsibilities are shared between actors on different scales from federal government down to the individual property owner or developer. Those roles must be clarified and defined by law. This is essential to minimize conflicting or overlapping responsibilities and to give clear mandates to specific organizations to undertake certain tasks combined with the provision of resources to undertake those tasks. A separate Tool, the 'Rapid Legal Assessment Tool', provides assistance in undertaking an initial assessment of the prevailing legal system and the roles that different actors take and gives guidance as to how gaps can be identified for the flood management sector.[24]

5.3 Institutional Coordination Mechanism

95 For land use panning to fully utilize its potential in flood management there is need for adequate coordination mechanisms between different sectoral planning agencies on the one hand and land use planning undertaken at the local or regional level on the other hand. Even though this

[23] This is for example the case in England where the Environment Agency has a lead role in providing advice in those cases.

[24] See : WMO, 2006: Legal and Institutional Aspects of Integrated Flood Management, pp. 51- 72. Flood Management Policy Series. Available at http://www.apfm.info/pdf/ifm_legal_aspects.pdf

requirement for horizontal and vertical integration in the flood risk management context have been voiced over decades in different forms, there are indications that in practice the integration of land-use planning and flood risk management has not been taken up in many places yet.[25]

5.4 Compliance and enforcement

96 To enforce existing land-use regulations, the administrator of a floodplain or local authority requires a series of legal powers. Land-use regulations or zoning ordinances usually provide such powers to administrators using various means of enforcement. Depending on the applicable laws and regulations an administrator may obtain legal powers, for instance:

- To take remedial action as necessary to prevent damage to property or danger to life
- To negotiate a schedule for the completion of the construction, repairs or other activity necessary to abate the violation;
- To initiate a civil or criminal complaint against the violator;
- To use work forces or contract to perform the required remedial actions, and submit an invoice to the person for payment;
- To initiate a procedure resulting in denial of flood insurance due to the violation of existing laws and regulations.

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[25] See: Greiving (2006)

GLOSSARY

Flood damage potential
The extent of possible damage in a given flood hazard area.

Flood management
The guidance and control of action required to deal with floods.

Flood fringe
That portion of the 100-year floodplain outside of the floodway (often referred to as "floodway fringe").

Flood plain
Nearly level land along a stream flooded only when the streamflow exceeds the water carrying capacity of the channel.

Flood vulnerability
The degree to which a socio-economic system is susceptible or resilient to the impact of flood hazards.

Floodway
The area regulated by Federal, state, or local requirements to provide for the discharge of the base flood so the cumulative increase in water surface elevation is no more than a designated amount within the 100-year floodplain.

Non-structural flood management measures
Flood forecasting and warning, land-use planning and control, flood insurance schemes, flood damage compensation, flood proofing, flood preparedness and response programmes.

Structural flood management measures
Dams, levees, weirs, detention reservoirs, bypass channels, channel deepening or widening, temporary flood defence structures (for flood emergency management).

100-year flood
The term "100-year flood" is misleading. It is not the flood that will occur once every 100 years. Rather, it is the flood elevation that has a 1- percent chance of being equalled or exceeded each year. Thus, the 100-year flood could occur more than once in a relatively short period of time.

REFERENCES

[1] EarthTrends Update: February 2008, Urbanization and Environmental Sustainability
[2] *By Crystal Davis and Amy Cassara*
[3] HTTP://EARTHTRENDS.WRI.ORG/UPDATES/NODE/287

[4] Applying the flood provisions in planning schemes - a guide for councils, August 2000
[5] Victoria Department of Infrastructure
[6] http://www.dpi.vic.gov.au/CA256F310024B628/0/87BA3CF01D92E497CA25712C00094CF3/$File/944+Flood+Provisions.pdf

[7] Applying for a planning permit under the flood provisions - a guide for councils, referral authorities and applicants, August 2000
[8] http://www.dpi.vic.gov.au/CA256F310024B628/0/92BB7442A7902262CA25712C000989AA/$File/944+FloodProv+AppforPermit.pdf

[9] Parker, D.J. (ed.), 1999: *Floods*, Volume I and II, Routledge, London

[10] APFM (Associated Programme on Flood Management), 2004, *Integrated flood management concept paper*, APFM Technical Document No.1, second edition (Geneva: Associated Programme on Flood Management, World Meteorological Organization).
[11] http://www.apfm.info/pdf/concept_paper_e.pdf

[12] Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks
[13] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:288:0027:0034:EN:PDF

[14] Planning Policy Guidance 25: Development and flood risk
[15] http://www.planning-applications.co.uk/ppg25_floodrisk.pdf

[16] PPS 25 (Planning Policy Statement 25): Development and flood risk, Communities and Local Government, 2006.
[17] http://www.communities.gov.uk/documents/planningandbuilding/pdf/planningpolicystatement25

[18] Environment Agency, 2004: Catchment Flood Management Plans, Volume I – Policy Guidance
[19] http://www.environment-agency.gov.uk/commondata/acrobat/cfmp_1426671.pdf

[20] Flood and Coastal Defence Appraisal Guidance FCDPAG3 Economic Appraisal Supplementary Note to Operating Authorities – Climate Change Impacts October 2006
[21] http://www.defra.gov.uk/environ/fcd/pubs/pagn/climatechangeupdate.pdf

[22] Stephenson, D., 2002, *Integrated flood plain management strategy for the Vaal.* In: Urban Water 4 (2002) 425 – 430.

[23] Turnbull, G.K. : The Investment Incentive Effects of Land Use Regulations, The Journal of Real Estate Finance and Economics, 31:4, 357–395, 2005

[24] Anderson, J.A.: Taxes and Fees as Forms of Land Use Regulation. The Journal of Real Estate Finance and Economics, 31:4, 413–427, 2005

[25] Bronstert, A., Niehoff, D., and Burger,G.: Effects of climate and land-use change on storm runoff generation: present knowledge and modelling capabilities. Hydrological Processes 16, 509–529 (2002)

[26] FAO (2000):Land–water linkages in rural watersheds. FAO Land and Water Bulletin 9.
[27] Available at ftp://ftp.fao.org/agl/aglw/docs/lw9e.pdf

[28] FAO (2005): Forests and Floods Drowning in fiction or thriving on facts?
[29] Available at http://www.fao.org/forestry/webview/media?mediaId=11722&langId=1

[30] Greiving, S., Fleischhauer, M., Wancura, S., *Management of Natural Hazards in Europe: The Role of Spatial Planning in Selected EU Member States*, Journal of Environmental Planning and Management, Vol. 49, No. 5, 739 – 757, Routledge, 2006

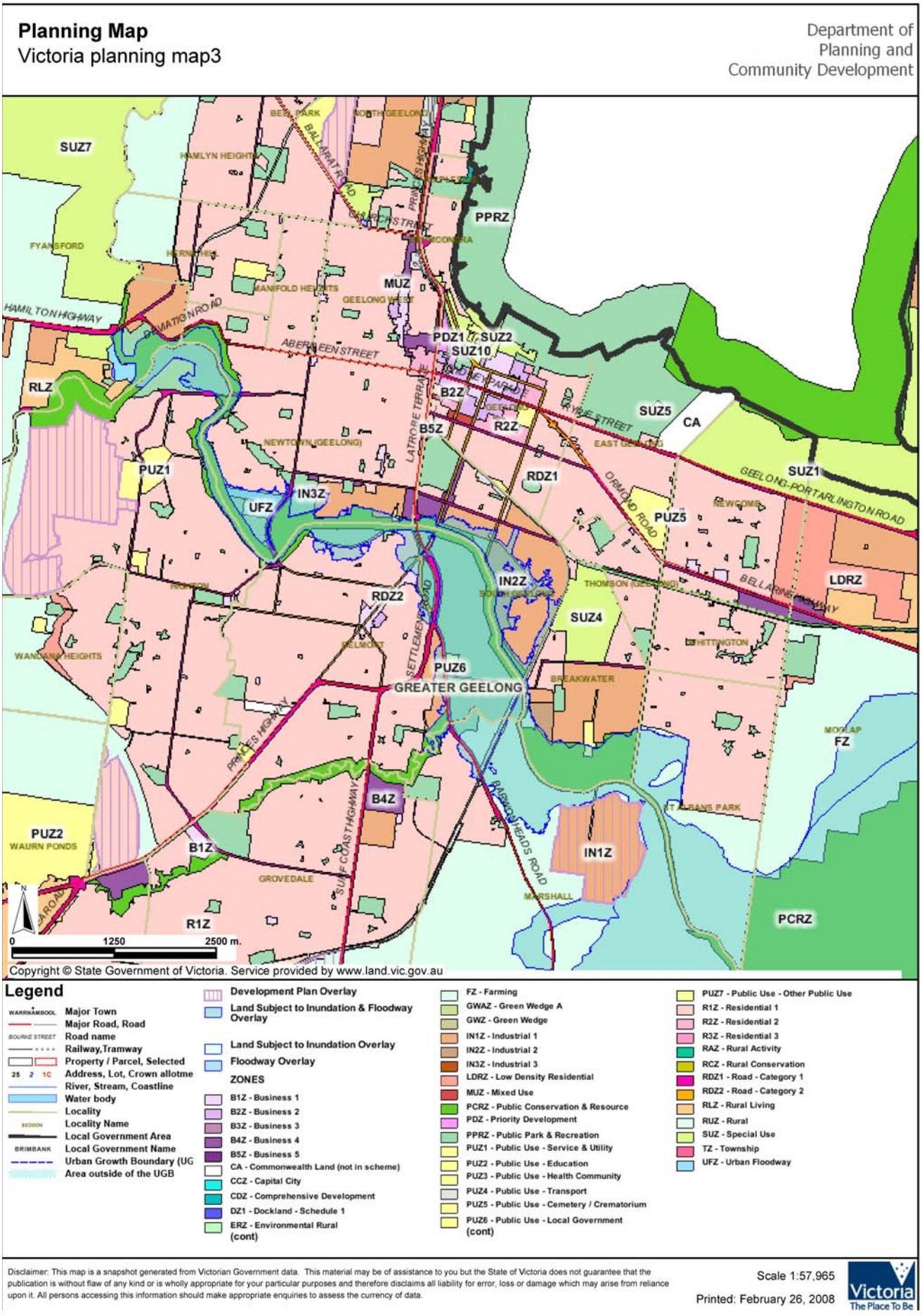
[31] Pottier,N. et. al., Land use and flood protection: contrasting approaches and outcomes in France and in England and Wales, Applied Geography 25 (2005) 1–27

Further reading:

- UK Online Planning Aid
  http://www.planning-applications.co.uk/floodrisk.htm

- Association of State Floodplain Managers, No Adverse Impact Toolkit, 2003
  http://www.floods.org/NoAdverseImpact/NAI_Toolkit_2003.pdf

ANNEX


Planning Map
Victoria planning map3
Department of Planning and Community Development
SUZ7
PPRZ
MUZ
PDZ1
SUZ2
SUZ10
B2Z
B5Z
R2Z
SUZ5
CA
RLZ
PUZ1
IN3Z
UFZ
RDZ1
SUZ1
PUZ5
LDRZ
IN2Z
RDZ2
SUZ4
PUZ6
GREATER GEELONG
B4Z
B1Z
PUZ2
R1Z
IN1Z
PCRZ
FZ
HAMILTON HIGHWAY
ABERDEEN STREET
LATROBE TERRACE
RYRIE STREET
GEELONG-PORTARLINGTON ROAD
ORMOND ROAD
BELLARINE HIGHWAY
SETTLEMENT ROAD
PRINCES HIGHWAY
SURF COAST HIGHWAY
BARWON HEADS ROAD
FYANSFORD
HAMLYN HEIGHTS
MANIFOLD HEIGHTS
GEELONG WEST
NEWTOWN (GEELONG)
EAST GEELONG
NEWCOMB
THOMSON (GEELONG)
HIGHTON
BELMONT
WANDANA HEIGHTS
BREAKWATER
MOOLAP
ST ALBANS PARK
WAURN PONDS
GROVEDALE
MARSHALL
0 1250 2500 m.
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Legend
Major Town
Major Road, Road
Road name
Railway,Tramway
Property / Parcel, Selected
Address, Lot, Crown allotme
River, Stream, Coastline
Water body
Locality
Locality Name
Local Government Area
Local Government Name
Urban Growth Boundary (UG
Area outside of the UGB
Development Plan Overlay
Land Subject to Inundation & Floodway Overlay
Land Subject to Inundation Overlay
Floodway Overlay
ZONES
B1Z - Business 1
B2Z - Business 2
B3Z - Business 3
B4Z - Business 4
B5Z - Business 5
CA - Commonwealth Land (not in scheme)
CCZ - Capital City
CDZ - Comprehensive Development
DZ1 - Dockland - Schedule 1
ERZ - Environmental Rural
(cont)
FZ - Farming
GWAZ - Green Wedge A
GWZ - Green Wedge
IN1Z - Industrial 1
IN2Z - Industrial 2
IN3Z - Industrial 3
LDRZ - Low Density Residential
MUZ - Mixed Use
PCRZ - Public Conservation & Resource
PDZ - Priority Development
PPRZ - Public Park & Recreation
PUZ1 - Public Use - Service & Utility
PUZ2 - Public Use - Education
PUZ3 - Public Use - Health Community
PUZ4 - Public Use - Transport
PUZ5 - Public Use - Cemetery / Crematorium
PUZ6 - Public Use - Local Government
(cont)
PUZ7 - Public Use - Other Public Use
R1Z - Residential 1
R2Z - Residential 2
R3Z - Residential 3
RAZ - Rural Activity
RCZ - Rural Conservation
RDZ1 - Road - Category 1
RDZ2 - Road - Category 2
RLZ - Rural Living
RUZ - Rural
SUZ - Special Use
TZ - Township
UFZ - Urban Floodway
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Scale 1:57,965
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Victoria
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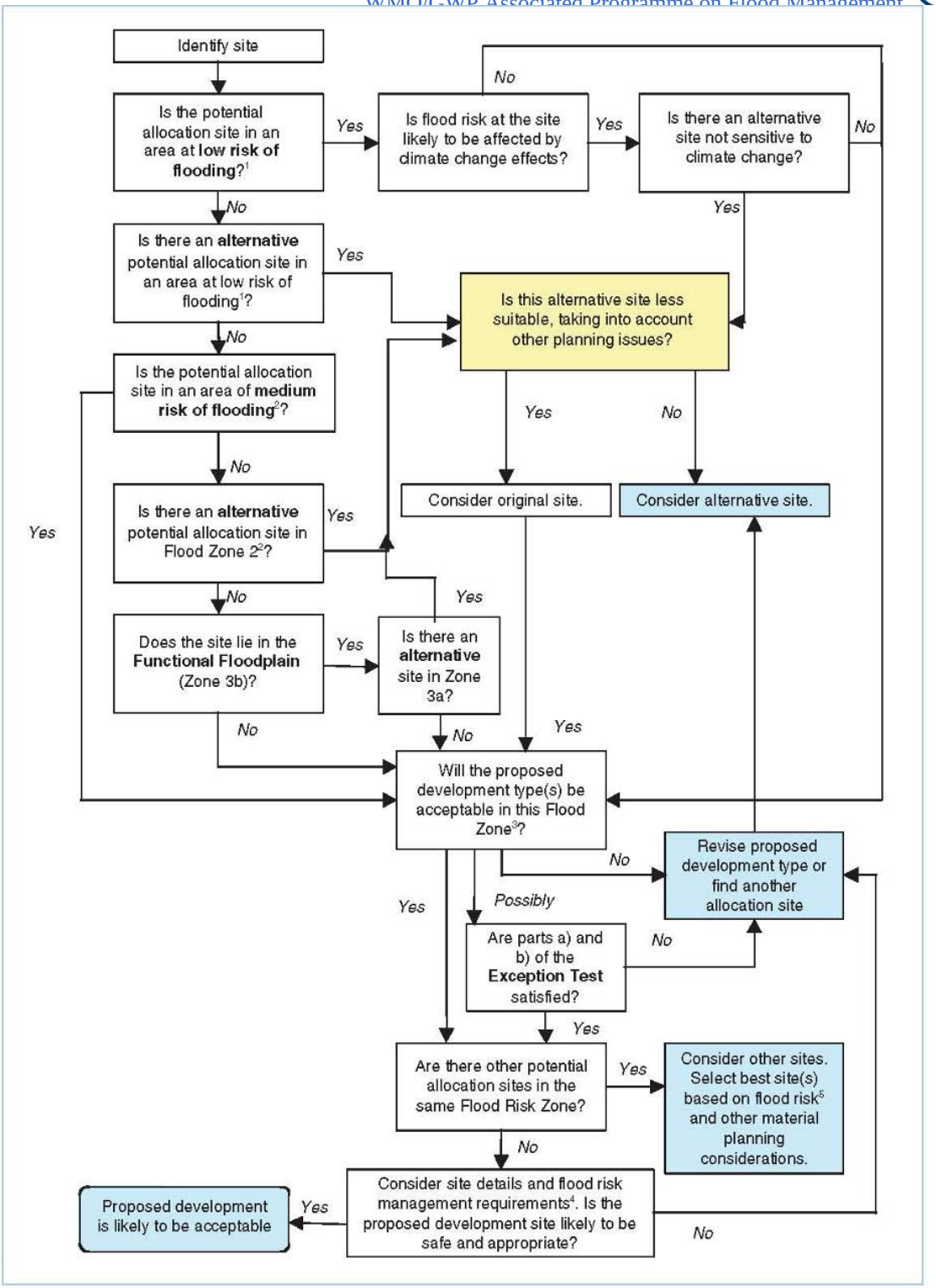

Notes

1 Flood Zone 1 for fluvial and tidal flooding and with a low risk of flooding from other sources.
2 Flood Zone 2 for fluvial and tidal flooding and with a medium risk of flooding from other sources.
3 As defined by the Sequential Test.
4 Development to be safe and to not increase flood risk elsewhere. Required to pass part c) of the Exception Test, where applicable.
5 Including susceptibility to future climate change and residual flood risk.

Source: Development and Flood Risk: A Practice Guide Companion to PPS25, 'Living Draft' http://www.communities.gov.uk/documents/planningandbuilding/pdf/324694