

FLOOD PREVENTION

1. Flood prevention is based both on physical means that the strategic means to prevent or reduce the risk that they represent. Physical flood prevention measures are, for example, to build dams and ponds, to change the course of a river and install dikes, levees, overflow basins, spillways and flood drainage works. With regard to the strategic measures, they include plans and regulations for the use of land in floodplains and watersheds as well as building standards and health standards.

Impacts potentiels sur l'environnement

2. Except in the case of exceptionally serious flooding, ecosystems and human populations of many regions adapt their activities to the periodic flooding of the land. Often flooding become generally problematic when natural events or human activities exacerbate their intensity or their frequency or when human multiplies, areas naturally subject to flooding, works and facilities and which must be protected.
3. Physical measures of flood risk creating significant environmental impacts that come from the disappearance of the natural rhythm of floods and the benefits they bring. These are the floods that made fertile floodplain and humidify the land and enrich in alluvial deposits. In arid regions , they may only make possible the natural irrigation and fertilization of land. Reduce or eliminate the risk of damaging floods recession agriculture , natural vegetation , wildlife and livestock living in floodplains and the fish populations in floodplains and rivers that are particularly suited to natural flood cycles . To maintain productivity modes of production based on natural processes , it is necessary to rely on mitigation measures, such as

fertilization or irrigation of farmland, pasture improvement and tighter management of intensive fishing and modes of production. Moreover, the rectification of rivers reduces the frequency of floods. At the same time, sediment from upstream areas of the watershed pass into the mouth of the river, unless overflow basins are present downstream thereof. Increased sediment loads in rivers can lead to physical changes in sedimentation and altered flow estuaries, deltas and coastal regions and have adverse effects on the fisheries resources of these ecosystems. Coral reefs are particularly sensitive to increased sediment also may be irreparably damaged.

4. The role of a dam and a reservoir is to reduce the maximum flow of waters flowing in a flood-prone area. Operation differs from a basin for irrigation or hydroelectric. Rather than seeking to maintain a high level of upstream and thus ensure a drop height maximum for the production of electricity or a maximum supply capacity for irrigation purposes, the operation of a dam aims to keep water level low enough before and during the season of floods, so as to have a sufficient capacity to contain the surplus. However, the subsequent successful discharge can cause problems. It happens, indeed, that land, that was heavily flooded over a short period, are now less, but over a fairly long period, which is not necessarily compatible with current agricultural production patterns.
5. The erection of levees and the improvement of the bed are part of physical measures of flood prevention that increase the capacity of a watercourse in and the speed of the current. The change of the bed of a watercourse may include its dredging in order to enlarge and deepen it, the removal of vegetation and other debris, its flattening and its banks as well as its rectification; all these means facilitate the flow of water in the

network and prevent flooding. The rectification of the bed also allows to eliminate the meanders and, thereby, the risk of overflow out of curves, there where the current is fastest and the level of water, the most high.

6. The change of the bed of a watercourse can cause a number of adverse effects on the environment. Any measure whose purpose is to accelerate the speed of the current accentuates the erosive effects of the water. Erosion and sedimentation problems can appear as well in the section as corrected only downstream. If paving the bottom and the banks of the bed of a watercourse to restrict, or even to eliminate factors that slow down the flow, it remains that this practice poses many problems to order both aesthetic and ecological, such as the reduction of the supply of groundwater and the disruption of aquatic populations. The levelling, dredging or dredging of a section as corrected also cause significant impacts on fish and aquatic organisms, by disrupting their habitat. The removal of material from dredging is another type of problems. On the other hand, and although improvements in the bed of a watercourse reduce flooding problems in the treated section, they simply displace the problem, because the floods are likely to increase in frequency and amplitude downstream.
7. The creation of artificial levees and improve natural levees and dikes increase the capacity of the bed of a watercourse to contain flood waters, except during floods. Just as the bed of a watercourse improvement measures, these works tend to move the floods to downstream regions which, in turn, suffer the consequences or are forced to mobilize themselves public funds to implement the flood prevention measures. Other hand, the dikes built in the floodplain to protect certain areas of flooding alters the hydrology and are likely to impact on habitats and wildlife and livestock movements.
8. Overflow basins are normally formed by the marshlands that lie between

the banks of a watercourse and the slopes of a valley. To these can be added artificial ponds in which are moving flood waters. Ponds or small embankments which is used near urban areas to intercept and collect runoff water, until they reach the River, are also effective in reducing peak flows. These basins have a positive impact by feeding groundwater and allowing the filing of suspended sediment that otherwise will elapse in the corrected section, they may however become a home conducive to the reproduction of disease vectors.

9. Weirs and spillways are channels or lines of derivation which can be naturally occurring or constructed by humans and which are used to derive the waters around or away from urban and densely populated areas. These waters returning downstream watercourse from which they emerged.
10. Flood prevention works are expensive. On the other hand, they give people a false sense of security by making them think they are guarded against flooding, while in fact they are only resolved. This feeling may encourage them to intensify the development of flood plains, which can have disastrous consequences if a flood occurred or if books came to give.
11. In addition to the impacts that the flood prevention works have on the environment, it is important to consider the natural environment factors affecting this prevention. Not only the infrastructure and other facilities of flood plains are exposed to varying risks according to their vulnerability, but these devices also increase risks to nearby communities and those who live downstream. Buildings, for example, by impeding the flow of flood waters, by decreasing the storage capacity of flood plains and by increasing surface runoff, can raise the level and increase the speed of the flood waters.

12. Fires, storms or changes in the route of a watercourse are natural phenomena that affect the flow of the flood. Human activities in a catchment area, as for example, logging or clearing land for agriculture, tend to increase runoff, especially when it comes to hillside agriculture and which does not have adequate terraces or the contour is not sufficiently consolidated plantations. Moreover, pave the lands located in a watershed and in a flood plain will also increase these phenomena and install a stormwater drainage system will raise the quantity and the speed at which they can drain into the river system.

Particular issues

Strategic measures and regulating the use of flood plains

13. The strategic flood prevention measures are aimed to prohibit or regulate the development of floodplains and watersheds and reduce the potential losses due to floods. As with preventive measures in general, they are less costly to manage treatment measures such as the establishment of physical measures strategic measures are mainly beneficial to the environment, to the extent that they are not trying to control the natural flooding of a watercourse. The current design, shared by many planners and policy makers, is it is better to leave intact the floodplains as natural overflow basins. The floodplain is already arranged, then it should have strategic measures in conjunction with physical measures.

14. The land use regulations are an effective way to control the development of a flood plain. The distribution of soil in farmland, parks and reserves is compatible with the protection of flood plains and is an obstacle to the use

of land vulnerable to flooding. The wetland naturally preventing floods, it is particularly important that the land use regulations prohibit activities that would begin their storage capacity.

15. The land use regulations may prohibit works or specify the types and the function of the works authorized in floodplains to reduce flood risk. For example, removal of sewage and toxic or hazardous substances may be subject to a ban, the protection of structures against floods be required and the construction of buildings or private roads that can intensify the effects of the floods, not be permitted.
16. Health and building regulations may contain other requirements for the development of flood plains. The first aim to reduce the health risks that might arise from contamination of water resources, if the floods disrupted sanitation. They may also prohibit the establishment of spreading devices (for example, septic tanks and fields of application) or require a permit for installation. Construction regulations may place conditions relatively to the structures of the new buildings that will make them less vulnerable to flooding will decrease the health risks will better ensure the safety of the occupants (in relation to, for example, standards of electrical installations and the number of storeys), and finally, to limit the effects of construction on the flow of flood waters.
17. The implementation of the policy measures of flood prevention requires a control of the land which belongs to the institutional field. The policy measures will become effective only if the Government is able to design and implement a sound policy of spatial planning.
18. Finally, certain actions will reduce or delay the runoff, increase infiltration, and therefore, reduce the risk of flooding. They include management

measures of the watershed (increase the vegetation cover, especially on sloping land, improve agricultural practices, build benches as a means of erosion control, etc.), the planting of vegetation along streams and rivers which will help to contain and absorb the flood and finally, protection or restriction of the use of wetlands which have a natural flood prevention effect.

Sociaux Issues

19. The uneven distribution of received profits and costs incurred by those affected by the flood prevention measures represents the most important social problem. In cases where traditional uses of a flood plain (fishing, agriculture and movement of herds whose survival depends on natural cycles floods) are disturbed by prevention measures to protect other communities (often urban), rural dwellers are often not sufficiently compensated for the losses they incur.

20. The inhabitants of floodplains are also those who are most affected by increased flooding due to the use of the land upstream and however, their power is so low that they can make the necessary changes or even get the Governments they intervene on their behalf.

Détermination de l'étendue de la plaine inondable et de la fréquence des inondations

21. To assess the risk of flooding to a place, calculate the probability of floods of magnitudes varied using the following information:
 - the annual maximum flow of the watercourse at the location in question. the interval of recurrence of various peak flows (interval of average time between occurrences of each peak flow);

- the water level (the physical limits of flooding) corresponding to each flow.

22. Statistical data on maximum rates (saved over a period of at least 10 years) and extent of flooded surfaces are often not available, historical information can be obtained of local residents, local surveys or alluvial deposits geological analysis to determine the frequency and the extent of flooding in the region. Maps can then be drawn up indicating the sectors that could potentially flood. they are particularly useful in the development of plans and planning regulations for the region.

Alternatives to projects

23. Both options can reduce the need for physical measures liable to disturb the environment:

- adapt the operation of dams and existing ponds upstream, so as to reduce the risk of flooding;
- to appeal, as far as possible, strategic measures as a way to reduce these risks.

24. The intensity and frequency of floods are increasing due to human activities in the catchment area, it should focus more on strategic solutions (such as restoration of revegetation of cleared areas, the protection of sloping land, planting trees along the river levees and the restriction of access to the region to prevent the migration of populations). On the other hand, where it is necessary to protect existing structures against floods, it may be that the only solution is to implement the physical measures of prevention. In this case and to reduce negative environmental impacts, the resident possibilities in the choice of measures, their implementation and their management.

Tracking and management

25. The right of public authority on watersheds and flood plains is hierarchically divided between local communities and regional and central administrations. This right may also be shared by governmental entities of equal rank but whose jurisdictions are traversed by a same watercourse or be allocated a more diffuse way between a number of technical or operational bodies. More administrative structure will be diffuse and it will be difficult to get a good coordination between the various disciplines of a technical nature and between the functions and programmes of action of each.

26. The adoption of a holistic approach to water management requires a wide range of professional skills in planning and policy development. In addition to the advice of engineers, economists and planners, the contributions of natural scientists (geographers, agronomists, forest, zootechnicians, experts in fisheries research and ecologists, for example) and social scientists are also needed. The participation of such a large number of experts in the prevention of flood management is a challenge.

27 . Government units responsible for the flood must have the capacity planning and regulations to :

- To determine the causes and frequency of floods and the extent of flooded areas ;
- Identify actual or potential effects of different types of development on flood levels ;
- Provide , implement or introduce physical or strategic measures for flood prevention;

- Establish a warning system ;
- To determine the most prone to flooding and take steps to prevent any development areas may create the risk of flooding ;
- Monitor changes may alter the risk of flooding and the effects of measures of flood prevention;
- Coordinate plans and activities of other agencies responsible for activities in the watershed.

27. These capacities are too low, it should develop the technical and administrative skills as well as regulatory and community relations.

28. The ability to implement strategic measures is an essentially institutional question. The Government services responsible for the prevention of floods should develop preventive measures that are provisionally strategic and specific to local conditions. The successful uptake of flood prevention measures is often dependent on the interest and the support of local communities, their ability and their willingness to change their ways to use lands and resources. An information campaign may also be necessary and enroll in a comprehensive programme of flood prevention. In remote areas where the Government has little influence, can stimulate action at the local level and promote the necessary changes by working with traditional structures of power and community organizations. The Government must strengthen and enhance linkages with these groups if they are too weak.

Monitoring

29. The factors that influence the quantities of water that is discharged into a watercourse or which are extracted as well as the capacity of the soil to absorb floodwaters and the dangers they represent must be monitored

continuously if we want to undertake a proper plan of a flood plain. The direct and indirect impacts of flood prevention works should be also examined closely. Regular follow-up should gather the following information:

- The quantity, intensity, duration and geographic distribution of rainfall and snowmelt ;
- The types of storms ;
- The soil moisture at various times of the year rate ;
- The flow of rivers (including the annual maximum flows) ;
- Storage , diversion and regulation of river water ;
- Changes in drainage and other factors affecting the stormwater runoff ;
- Sediment load of river water ;
- Sedimentation problems in downstream areas ;
- Changes the course and the river beds ;
- Demographic changes in floodplains and watersheds ;
- The use of rural and urban land (regulated and unregulated employment land in the floodplain and watershed change);
- Socio -economic impacts due to the project (including changes in , pastoral farming practices and existing fishing);
- The effects of measures to prevent flooding on freshwater fisheries , estuaries and coasts ;
- The effects of measures to prevent flooding on the vegetation of floodplains;
- The effects of flood prevention measures on natural areas and wildlife and their habitats.



OPERATIONAL GUIDLINES OF BOAD

Flood prevention

Potential negative impacts	Mesures d'atténuation
Impacts directs	
1. Floods of lesser importance but longer duration in the floodplain at the opening of the dam.	1. Modify agricultural practices to adapt to the conditions.
2. Risk of failure of structures and danger of water levels exceed the height or render ineffective the preventive measures in place to control, endangering the lives and property of people at risk, either because the project does not strictly comply with security measures initially recommended or because the development of the floodplain accelerated after project completion.	2. Implement policy measures to curb increased risks of flooding as well as a warning device.
3. Breaking the cycle of enrichment of soils and groundwater downstream structures supply.	3. In the presence of dams can partially mitigate the effects by regulating the quantity of water discharged so that they approach the natural flow.
4. Resettlement of population and other socio-economic impacts that face the communities affected by the project.	4. <ul style="list-style-type: none"> • Determine populations at risk or those that may suffer the consequences of flood prevention measures. • Integrate the protection and the interests of the groups concerned in the design of the project and the cost analysis to reduce losses or to offer financial compensation in Exchange benefits and lost property.
5. Adverse effects on fish and aquatic resources caused by the disruption of migration routes, Habitat deterioration and alteration of the quality of water (sediment accumulation, for example) which, in turn, lead to a decrease in the productivity of the freshwater fisheries, offshore or coastal.	5. <ul style="list-style-type: none"> • Install fish ladders. • Protect the fish breeding grounds. • Provide integrated management of fisheries including rearing and restocking programmes.



Prévention des inondations (suite)

Potential negative impacts

Mesures d'atténuation

Impacts directs (suite)

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| <p>6. Negative impacts of measures of rectification of a watercourse:</p> <ul style="list-style-type: none">• disturbance of fish habitat that entail the levelling of the bed of the watercourse;• the temperature rise of the water caused by the removal of the vegetation on the banks and in the water course;• worsening the problems of erosion and sedimentation;• erosion of the bed and the shores;• flooding and downstream sedimentation. | <p>6.</p> <ul style="list-style-type: none">• Carefully make the choices of engineering during the planning phase.• Limit the magnitude of the correction of the course of water or its maintenance.• Put in place mitigation measures following the construction phase.• Avoid to minimize possible length of the watercourse while preserving a few twists and turns.• Limited excavation and backfilling.• Limit the destruction of the vegetation on the shores and in the bed of the watercourse.• Replanting or reseeding the shores.• Carry out the excavation from a shore |
| <p>7. Adverse effects of the works.</p> | <p>7.</p> <ul style="list-style-type: none">• Reduce these effects by avoiding obstruction of the natural flow, too abundant runoff, the uncontrolled soil erosion and air pollution.• Redevelop borrow, control the land clearing and disposal of excess earthworks.• Restrict access by vehicles to the banks of the watercourse. |
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Prévention des inondations (suite)

Potential negative impacts	Mesures d'atténuation
Direct Impacts	
8. Reduction of pasture in the floodplain due to ecological changes and the intensification of development (agriculture irrigated, for example).	8. <ul style="list-style-type: none"> • Fodder crops, use the by-products of irrigated crops and finally, to find other sources of water supply. • Take into account the use of rangelands (by the semi-nomadic flocks, for example) in the development plans to ensure that pasture and water resources in the Valley during the dry season are sufficiently abundant.
9. Reduction of flood recession agriculture.	9. Maintain, wherever possible, a natural diet of floods in most productive lands (and where to practice intensive agriculture) avoiding to install flow control structures in water courses or by installing equipment to floods 'semi-controlled.
10. Barriers (levees, dikes, etc.) the movement of wild animals	10. Build bridges or crossing tracks.
11. Loss of natural areas and wildlife habitats.	11. <ul style="list-style-type: none"> • Determine the most important habitat and strive to protect them by providing flood prevention measures. Avoid, as much as possible, to modify existing rates if habitats or species depend the natural flood regime.



OPERATIONAL GUIDLINES OF BOAD

Prévention des inondations (suite)

Potential negative impacts	Mitigation measures
Directs Impacts	
12. Problemes floods created downstream.	12. <ul style="list-style-type: none">Protecting natural areas of overflow downstream.Create overflow basins.
Indirect Impact	
13. Increasing access and opportunities to the floodplain development and sense of security, once taken flood prevention measures, resulting in an influx of people attracted to agricultural development, logging, poaching and the development of infrastructure, etc.	13. <ul style="list-style-type: none">Restrict access as far as it can.Plan the influx of populations and implement rural development activities.Introduce strategic prevention measures.
14. Greater use of fertilizers to remedy the loss of soil fertility, leading to pollution of the waters and making farmers dependent on the import of these products.	14. <ul style="list-style-type: none">Establish periods and optimal application rates. Use atmospheric nitrogen-fixing crops. Replace chemical fertilizers by organic fertilizers.