Basic Planning

General Description

With the nation's peculiar climate condition, severe geomorphologic features, and social condition under which narrow alluvial plains are densely inhabited and the land there is densely used, proper land management is indispensable to support safe and comfortable daily lives of the citizens as well as advanced economic and social activities while conserving a rich natural environment. Also with arising many water-related problems caused by global warming and those concerning the safety of water including dioxin pollution, it is anticipated that land management associated water will grow to be increasingly important and complicated.

In order to properly implement land management, it is important to comprehensively manage land and water, which are important components of the national land, from the view points of disaster prevention, proper use of resources, and environmental conservation. For smooth, efficient, and comprehensive management of land and water, it is necessary to share with the citizens issues and goals of management of water, sediment, etc. and to implement hardware-based measures such as the development and improvement of erosion and flood control and seacoast preservation facilities which are organically linked with software-based measures such as land utilization guide and damage mitigation countermeasures.

Moreover, these measures need to be implemented within a system in which research of the present condition, planning of measures, implementation of measures, monitoring and assessment, and feedback are conducted in this order.

Explanation

Due to its natural conditions such as its geographical, morphological, geological, and climatic features, Japan has a land which is vulnerable to disasters and draughts caused by typhoons, rain and snow storms, earthquakes, and volcanic eruptions, and it has suffered a series of major disasters caused by floods, landslides, and volcanic eruptions in recent years. Also, because the nation's population and assets are densely concentrated in certain areas, a major disaster in such areas may result in extensive, catastrophic damages. These natural and social conditions also make it difficult to implement the use of resources such as land and water and the development and improvement of social infrastructures such as transport networks. Moreover, in years to come during the 21st century, occurrences of abnormal rain storms and unexpected disasters associated with drastic climate changes caused by global warming, etc., further progression of desertification, occurrences of acid rain, reduction of water usable as resources, frequent occurrences of droughts, and other problems caused by expected changes in the water environment which will give adverse effects to the desired establishment of a healthy hydrological cycle system are anticipated. These problems have been added to by the problem of the contamination of water by substances such as dioxin being diffused through water. The following is an overview on the nation's major natural and social conditions.

1. Natural conditions

With steep backbone mountain ranges running through the central part of the long and narrow archipelago of Japan, most of its rivers are also steep. Also, since it is located in the Asian monsoon region, Japan is characterized by the concentration of rainfalls during the rainy season and the typhoon season. This causes water to flow downstream for short periods of time when a flood occurs, and the peak flow volume becomes extremely large compared to the normal flow volume while a long duration of no rainfall causes the amount of water to drastically decrease easily resulting in a water shortage. With a wide extension of the vulnerable geology which has been produced as a result of crustal deformation caused by many tectonic lines such as the Median Tectonic Line combined with the rainfall and geographical characteristics, landslide disasters tend to occur easily. Thus, in Japan floods and landslide disasters happen very easily, and its geological features make it difficult to stably utilize rainfalls as a source of water.

At the time of the Jomon Transgression approximately 6,000 years ago, the majority of Japan's plains where many big cities such as Tokyo, Osaka, and Nagoya are now located presumably used to have their coastlines much toward inland from the present ones. Most of these plains lie on a young weak foundation called alluvium which cumulated within the past 10,000 years. Therefore, compared with the urban areas of European countries, which developed on the strong diluvium formed approximately 2 million years ago, solid safety measures for buildings and other structures are very important in Japan's major cities. Moreover, in the urban areas of our country, there are many cases that the water levels of the river at the time of a flood are higher than the surrounding elevations. In addition, excessive pumping of groundwater has invited land subsidence, and as a result, the downstream areas near the river mouths spread at sea level, and they are endangered by probable disasters caused by not only floods but also high tides.

In the 21st century, due to global warming and resulting changes in climatic conditions, the global water environment is anticipated to change resulting in a number of issues to arise from the viewpoint of establishment of a healthy hydrological cycle system.

Furthermore, despite its land area counting only about 0.3% of the global land area, Japan is one of the most earthquake-ridden countries, experiencing approximately 20% of the earthquakes larger than magnitude 8.0 which occurred in the world between 1900 and 1994 in or around its land area. Also, Japan is one of the premier volcanic countries where about 10% of all the active volcanoes of the planet exist.

2. Social conditions

Along with the progression of urbanization, the population and assets of our nation have been highly densely concentrated in certain areas. For example, approximately 90% of the entire population dwell in the city planning areas which count approximately 25% of the national land area, and approximately 50% of the entire population and approximately 75% of the nation's total assets are concentrated within the flood susceptible areas of the alluvial plains which occupy about 10% of the national land area. For this reason, once a disaster occurs, it may result in enormous damages. While its water resources have been used from old ages as agricultural water as well as for power generation, industrial use, and water supply, wastewater is returned to rivers after processing in the sewerage system, etc. and efficiently reutilized for various purposes further down the rivers. Recent years have also seen the rise of water safety problems such as diffusion of dioxin and other toxic substances through water.

3. Natural environment

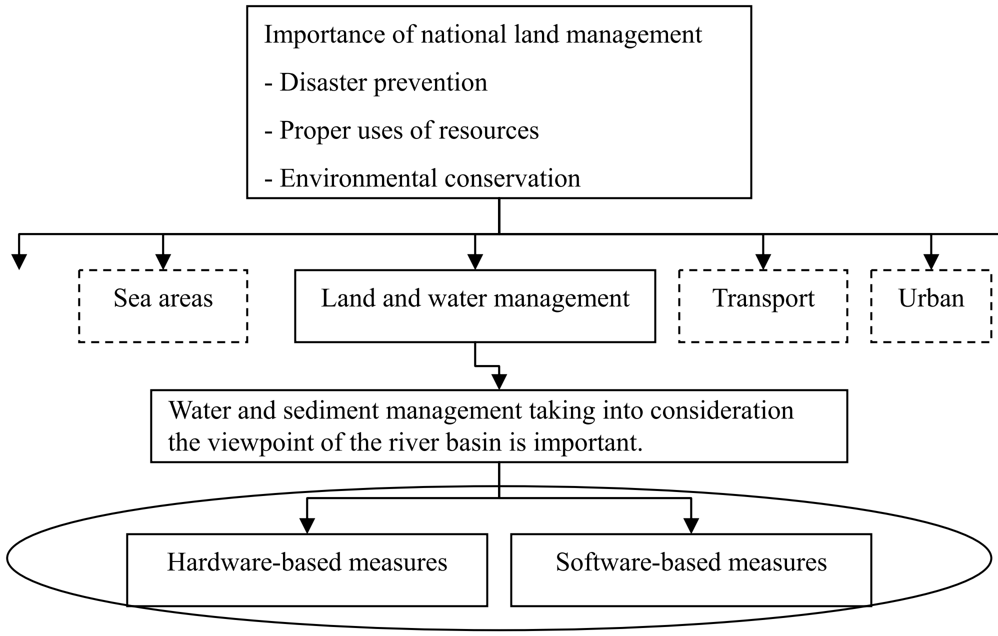
The major factor which allows diversified organism species to live and grow in our country is its multiphase natural environment featured by the particular climate zones ranging from the subtropical to subarctic zones as well as many uphills and downhills of widely different elevations. In addition, rivers not only have a flood control function and is used for various beneficial purposes, but they also function as places where an affluent and healthy living and regional culture that take advantage of the rich natural environment and waterfront spaces are fostered.

In order to achieve optimized conservation and proper use of the national land with such natural and social conditions, it is necessary to appropriately manage its components including the land, water, sea areas, atmosphere, transport, and cities, etc. while also considering the effects that are given between them. Among these components, it is particularly important to comprehensively manage the land and water from the viewpoints of disaster prevention, proper use of resources, and environmental conservation. To facilitate its achievement, comprehensive water and sediment management measures that combine hardware-based measures that require the development and improvement of erosion and flood control and coastal preservation facilities, and software-based measures that require efficient utilization of existing facilities and land utilization guide, as well as natural environment conservation. In addition, it is also important to provide information to and share tasks with the citizens, thereby supporting them start thinking about water-related issues and act on them on their own initiative.

National land management should be implemented within the framework of a system which ranges from planning of measures based on the present condition, implementation of measures, monitoring and assessment, and feedback to be reflected on future planning in this order. This is because these processes are closely related with each other, and the natural and social conditions are constantly changing.

Chapters 1 through 6 of the Basic Planning part are based on the following policies of description.

1. The basic policy of water and sediment management on which plans in Chapter 1 are based is described before descriptions of individual plans.
2. Chapters 2 through 4 describe basic concepts on which various statutory plans are based.
3. Chapters 5 and 6 describe those items included in the policy description in Chapter 1 which could not be stipulated because of existing statutory plans, the necessity for cooperation with the river basin, and the necessity and important points of the system which encompasses monitoring and assessment, as well as feedback to them.


Importance of national land management
- Disaster prevention
- Proper uses of resources
- Environmental conservation
Sea areas
Land and water management
Transport
Urban
Water and sediment management taking into consideration the viewpoint of the river basin is important.
Hardware-based measures
Software-based measures

Chapter 1 Basic Policy

Section 1 General Information

Water and sediment management for the purposes of disaster prevention, appropriate resource use, and environmental conservation involves the comprehensive management of land and water resources, important components of the national estate.

Water and sediment management needs to be implemented systematically and from a long-term point of view. It needs to aim at securing a domestic balance as well as overall balanced river systems for disaster prevention and mitigation, appropriate use of rivers, maintenance of normal water flows, improvement and conservation of riverine environments, maintenance of a healthy hydrological cycle, and comprehensive sediment management. At the same time, regional characteristics, project costs, including life cycle costs, and the effects and influences of all individual management projects, have to be considered.

To comprehensively implement such management programs, various plans must be established. They include basic policies for river improvement and river improvement plans, erosion and sediment control master plans, landslide prevention plans, and plans for seacoast preservation. Such plans are aimed at proper water and sediment management. They are established at the river basin level and should be consistent with each other. Policies based on these plans should be organically linked and implemented.

Management of land including water and sediment can achieve optimal effect if the people who live and work there recognize its tasks and importance, and positively tackle the tasks. Therefore, it is important to share information and collaborate with related administrations, residents, enterprises, or organizations.

Explanations

River systems are an essential part of the hydrological cycle. They carry precipitation to the sea, transport eroded soil and sand, and provide habitat for flora and fauna. The relationship between rivers as natural objects and humanity originated in the use of rivers by people and in the natural processes presented by rivers to people in various forms. Since rivers faithfully reflect the status of their basins, human activities in the rivers and their basins change the rivers and the relationship between the rivers and the people.

For instance, urbanization reduces the water retention and flow retardation functions increasing flood runoff and the occurrence of urban flood disasters. In turn, these events lead to loss of the alimentation function [replenishment] of ground water, depletion of spring water, and reduced river flow. To address these problems, comprehensive flood-control projects have been introduced in some river basins to promote the proper use of land through such measures as: the installation of rainwater storages at the time of new development, enhancing water retention in the river basins, through forest and paddy fields; maintenance and securing of flow-retardation functions; publication of inundation records, and recommendations for dwelling styles that take the possibility of flood damage into consideration[development control].

As lifestyles and industry have developed, pollutants have begun to be discharged into rivers at levels beyond the purification capacity of river systems, resulting in water quality deterioration. The original features of rivers have been lost, and riverine environments have deteriorated as a result of reductions in river volume caused by the rationalization of agricultural water intake and the formation of river bypasses for channel-type power generation, and occurrence of recession areas. In some regions, changes to the hydrological cycle have created serious negative impacts, such as ground subsidence from overextraction of ground water and the lowering of water tables in urban areas. In addition, as energy-intensive urban activities have led to the increased heat-island phenomena, attention has turned on the thermal amelioration effects of rivers and riparian areas in urban areas. Consequently, because proper regulation of the effects of rivers on people and efficient use of rivers by people are interdependent, it is vital to optimize the status and expected functions of rivers and their basins from a general viewpoint that is based on natural and social conditions.

Here, the ideal situation of a river and its basin determines their desirable status and that of the relationship between, as compared with their current natural and social states. The expected functions of the river and its basin determine what can be expected from them when their status is optimized.

In light of this point, in the implementation of water management it is important to promote the necessary policies and projects as part of integral and comprehensive management of the volume and water quality of the river. The aim should be to establish a healthy water cycle system that takes full advantage of the various functions that the river system originally had. To this end, plans that aim to establish a healthy water cycle system and take into consideration not only the river volume but also the water intake and discharge system, including the networks of channels in the river basin and the ground water, are called for.

In contrast, in mountainous areas, on plains, in coastal areas, and in estuaries, various problems associated with soil and sand movement are apparent, including degradation, estuary closure, and shoreline retreat. To solve these problems, improve the stability of channels, secure flood control, manage rivers, improve the functionality of coastal facilities, and conserve the environment, it is necessary to promote comprehensive sediment management by identifying not only the water system but also coastal areas as part of the entire sediment transport system in terms of quantity, quality, and time.

Projects for the proper management of land and water need to be implemented systematically, taking into consideration the project cost, including the life cycle cost and the effects and influences of the project. Therefore, assessments of the effects of a project need to take into consideration its life cycle, the benefit–cost ratio, and any peripheral influences (external economy, etc.).

In order to properly manage water and sediments, in river planning, including planning for flood control, water utilization, and environmental improvement and conservation (Chapter 2); erosion control planning, including countermeasures for sediment disasters and planning for environmental improvement and conservation (Chapter 3); and seacoast preservation planning, including coastal protection and environmental improvement, conservation, and utilization (Chapter 4), it is necessary to take a whole river basin perspective and adjust these plans to secure a balance in the entire river system. This shift helps in disaster prevention and mitigation management, proper use of rivers, maintenance of normal water flows, improvement and conservation of riverine environments, and comprehensive sediment management to realize the above goals and construct a healthy water cycle. In focusing on sediment movement it is necessary to consider not only the river system, but the entire sediment system, including seacoast areas.

When we examine these issues, we need to examine plans involving boundary areas between erosion control and river, and those between rivers and seacoasts, but since the phenomena occurring around these areas are complicated and there is much that is still unexplained, studies need to continue in future.

Also, we need to conduct studies to develop a comprehensive plan for basic policies, including that for river basins.

In developing the plan it is important to achieve accountability, and it is necessary to consider consistency with other plans and the ensuring of transparency. Also, the people need to take an interest in water-related matters, develop solutions, and then act to support these issues. We therefore need to gather and improve all water-related information and provide this information to the people so that they can share and utilize it.

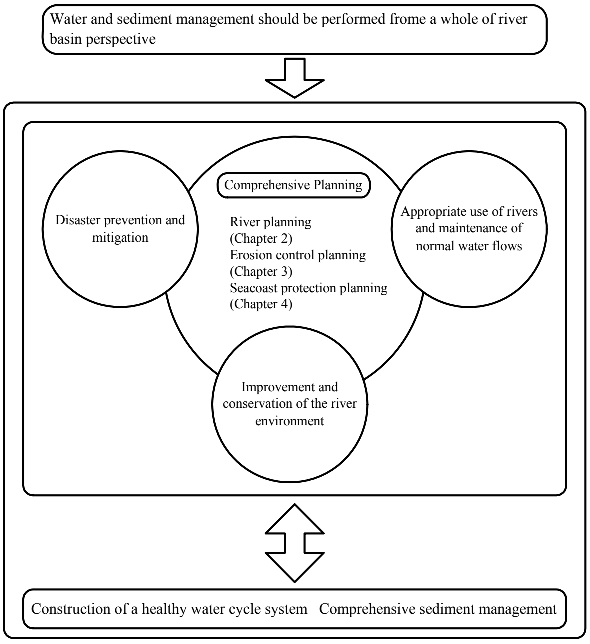


Fig. 1–1 Comprehensive planning

Section 2 Disaster Prevention and Mitigation

2.1 Overview

Disaster countermeasures need to be implemented systematically and from a long-term viewpoint to ensure safety and security in a fragile land, to develop a sustainable society, and to realize the efficient use of land and environmental conservation.

Planning of disaster countermeasures has to not just attempt to prevent disasters from external forces of a certain magnitude, but also to minimize damage if such forces are exceeded.

Explanations

It takes a long time for disaster countermeasures to actually start functioning, and although in some cases they bring instantaneous effects when they are implemented, in other cases they do not have effects until a certain degree of improvement occurs. Therefore, the systematic implementation of disaster countermeasures while constantly adopting a long-term perspective makes the countermeasures more efficient and effective.

In planning countermeasures to possible disasters, consideration of damage prevention against a certain magnitude of external force in terms of the capacity of future and present scales of planning and the present facilities is not enough; it is also important to minimize the damage by implementing both hard (structural) and soft (non-structural) measures jointly with the river basin if an excessive external force should occur.

This section describes countermeasures to flood, sediment, and earthquake disasters.

2.2 Countermeasures to flood disasters

A flood disaster can be defined as damage to human lives, properties, and social and economic activities through floods or tidal waves.

Planning of countermeasures to possible flood disasters should be primarily based on the prevention or mitigation of flood disasters against a certain magnitude of external force such as rainfall, and it should take into consideration the minimization of damage if a phenomenon that exceeds a certain magnitude should occur.

Also, it is important for countermeasures to flood disasters to take into consideration the characteristics of the river and flood, the form of the flood disaster, and the situation on the floodplain, and to aim to achieve a proper balance in the entire river system, including a balance between the upper and lower reaches and the main stream and branches.

Explanations

Since countermeasures to flood disasters need to address problems caused by natural phenomena, and there are social, financial, and technical constraints, it is impossible to totally prevent flood disasters caused by a flood or tidal wave of any magnitude. Therefore, countermeasures to flood disasters should be planned on the basis of protection against a flood or tidal wave of a certain magnitude under various constraints.

Although flood disasters caused by phenomena exceeding a certain magnitude occur rarely, if they do occur the resulting damage can be anticipated to be enormous. Consequently, the implementation of countermeasures to

flood disasters when a phenomenon greater than a certain magnitude occurs should include software-based measures aimed to mitigate the flood disaster as much as possible.
In addition, it is necessary to plan countermeasures to flood disaster that are properly balanced as part of the entire river system. Because, in general, a flood in the lower reaches of a river or in the main stream brings a greater scale of disaster than one in the upper reaches of the river or in a branch, it is important to maintain a balance between the upper and lower reaches and between the main stream and branches in the planning of countermeasures and the improvement of facilities. Planning of countermeasures to flood disasters needs to take into consideration various factors, including the past flood disaster record, the characteristics of the flood, the scale of damage potential on the floodplain, the form of land use, and the relationship between the floodwater level and the ground level in landslide-prone areas. Also, in cases where inland flooding occurs frequently but there is a high level of security against foreshore water flooding, or the level of security against inland is high but there is a low level of security against foreshore flooding, there is not a proper balance between protection against floods and countermeasures to landside water. In cities and their surrounding areas, changes in runoff into rivers may be caused by urbanization and residential land development, and high concentrations of population and assets within the flood area may exacerbate flood disasters. In such cases, it is necessary to make efforts over the entire basin toward not only drainage and river improvement but also runoff control by controlling land use and by building water storage and infiltration facilities. In the broad sense of the term, this also constitutes the securing of a balance between the river basin and the river.

2.3 Countermeasures to sediment disasters

Sediment disasters can be defined as damage to human lives, properties, and public facilities through sediment movements such as landslides and erosion of mountainsides or slope surfaces, sediment flows, earthflows, or landslides.
Countermeasures to sediment disasters should be implemented efficiently and effectively and based on knowledge of the mechanisms of sediment movement and disaster occurrence. They should appropriately combine structural measures such as the building of facilities and soft measures such as the establishment of warning and evacuation systems. These should also take into consideration as much as possible, and as required, the balance of sediment movement over the entire sediment transport system, including in seacoast areas.
Furthermore, the implementation of countermeasures to sediment disasters needs to be aimed at not only preventing disasters on a projected scale but also minimizing the damage if a disaster of excessive scale should occur.

Explanations

Sediment movement takes place in the following three major forms:

- Failure, erosion, and landslide on a slope such as a mountainside or cliff due to the action of rain and ground water (slip erosion and landslide)
- Flood caused by the accumulation of aggregates of water and sediment, which are transported downstream in a steep stream (mass transport)

- Downstream transport of sediments created by riverbed and riverside erosion (individual transport).

Sediment disasters occur as a result of one of these three forms of sediment transport.

Slope failure and earthfalls usually occur on steep mountainsides or slopes and directly damage houses and arable land. Since it is not clear in many cases how landslide occurrence is related to rainfall, we need to develop a proper understanding of the geography and geology of areas where landslides may occur.

Other sediment disasters include those caused by snowslides in the presence of snow cover and drift wood, and lava or pyroclastic flows caused by volcanic eruptions.

Because of the complicated nature of the occurrence mechanisms of sediment disasters, the realization of countermeasures takes a long time, and in implementing such plans, it is necessary to ensure that early effects can be obtained, not only against phenomena on a projected scale but also against more frequently occurring sediment disasters on a smaller scale.

In addition, countermeasures to sediment disasters need to be implemented effectively, not just with hardware-based measures such as construction works, but also with a combination of software-based measures such as the establishment of warning and evacuation systems and the restriction of land use.

2.4 Countermeasures to earthquake disasters

The purpose of a countermeasure to an earthquake disaster is to protect river administration facilities, erosion control facilities, and coastal protection facilities from disasters caused by seismic motion; to prevent and mitigate resulting secondary disasters such as flood and sediment disasters; and to prevent and mitigate disasters caused by tsunami.

For protection against seismic motion the necessary seismic performance should be determined on the basis of the characteristics of the river and the erosion control and coastal facilities. For protection against tsunami, countermeasures that include coastal protection should be implemented.

Explanations

Countermeasures to earthquake disasters include the securing of seismic performance against seismic motion and disaster prevention measures against tsunami. The following should be taken into consideration in the planning and implementation of countermeasures to seismic motion disasters.

1. On the basis of the seismic characteristics of the region and river of interest, erosion control and coastal facilities and their ability to withstand earthquakes should be secured. Design methods are described in “Technical Criteria for River Works (Draft) Design”.
2. For important facilities, it is important to adopt a design that takes into consideration the long recurrence interval of disastrous earthquakes and to implement soft measures such as a regional disaster prevention plan.

The following should be taken into consideration in the planning and implementation of countermeasures to tsunami disasters:

1. In coastal areas where the possibility of earthquake occurrence has been pointed out but no major earthquakes have occurred for a long time, it is necessary to consider countermeasures to an earthquake and

tsunami of the maximum scale predictable from existing knowledge.

2. Countermeasures to tsunami disasters need to be comprehensive, combining the improvement of disaster-prevention facilities, city and town planning from the viewpoint of tsunami disaster prevention, and the establishment and improvement of disaster-prevention systems. Countermeasures for coastal areas should take into consideration the fact that disasters can take diverse forms, depending on the geography, use of coastal areas, and land uses.

Section 3 Proper Use of Rivers, Maintenance of Normal Water Flows, and Improvement and Conservation of Riverine Environments.

The purpose of proper use of rivers, maintenance of normal water flows, and improvement and conservation of riverine environments is to ensure a safe and secure living environment, sustainable development of society, efficient use of national land, and environmental conservation. To this end, we need to achieve the following for not only rivers but also their basins: 1. Proper use of rivers and maintenance of normal water flows 2. Conservation and restoration of a good living and growing environment for plants and animals 3. Maintenance and formation of an aesthetically pleasing landscape 4. Maintenance and formation of places for activities that bring humans into contact with rivers 5. Conservation of good water quality.

Explanations

The purpose of proper use of rivers, maintenance of normal water flows, and improvement and conservation of riverine environments is to ensure a safe and secure living environment, sustainable development of society, efficient use of national lands, and environmental conservation. These goals are positioned as important elements of national land management, as described in the Section 1 General Information.

Here, 'river environment etc.' includes riverine, coastal, and mountain stream environments.

To achieve proper use of rivers, maintenance of normal water flows, and improvement and conservation of the river environment, the following goals need to be realized at the same time as efforts are made within the river basins:

1. Proper use of rivers and maintenance of normal water flows

Proper use of rivers and maintenance of normal water flows are aimed at maintaining the original functions of the running water in rivers. These functions comprehensively include the occupation of running water; navigation; fisheries; tourism; conservation of clear running water; prevention of salt damage; prevention of estuary closure; protection of river administration facilities; maintenance of ground water levels, landscapes, and lives and the growing environments of plants and animals; and procurement of places for activities that bring humans into contact with rivers.

2. Conservation and restoration of a good living and growing environment for plants and animals

[The aim of …]Conservation and restoration of a good living and growing environment for plants and animals aims to conserve and restore biological communities and living and growing environments that are in harmony with the river, and to maintain these over many years to come.

3. Maintenance and formation of an aesthetically pleasing landscape [Preservation of Landscape values]

Maintenance and formation of an aesthetically pleasing landscape means the maintenance and formation of a water-based landscape in which rivers are naturally present; this landscape should be based on the natural river landscape and the historical and cultural background of the region.

4. Maintenance and formation of places for activities that bring humans into contact with rivers [Enhancing interaction between humans and rivers]

Maintenance and formation of places for activities that bring humans into contact with rivers enables humans to contact nature in a symbiotic relationship without having a major influence on nature.

5. Conservation of[Protecting] water quality

Conservation of good water quality encompasses the securing of a level of water quality necessary for the proper use of rivers, the maintenance of normal water flows, and the conservation of river environments.

Section 4 Comprehensive Sediment Management

To achieve disaster prevention and mitigation, proper use of rivers, maintenance of normal water flows, and improvement and conservation of the river environment it is important to promote comprehensive sediment management. Comprehensive sediment management is implemented to address the problems associated with sediment movement that are occurring in fields in mountainous and piedmont areas, in alluvial fans, on plains, and in estuarine and coastal areas. If individual countermeasures against the problems faced by erosion control, dams, rivers, and seacoasts cannot solve these problems, then comprehensive sediment management should not be limited to individual solutions for these fields. Instead, it should identify sediment movement as part of the concept of sediment transport and should provide the necessary countermeasures, such as sediment-generation control and adjustment of sediment runoff, as part of the entire sediment transport system in order to solve these problems.

Explanations

Since Japan is located in the circum-Pacific orogenic zone, has a fragile geology, and is covered with precipitous terrain, the environment is marked by the high rates of erosion associated with steep and mountainous terrain. Sediments produced in the mountains and plateaus are carried downstream by rivers, to form alluvial fans and floodplains, and/or are transported to the coast where they enter the coastal sand drift system to form coastal sedimentary topographies. In Japan, space used as a primary source of people's livelihoods comes from the land formed by sediments transported by rivers.

Some forms of sediment transportation impair the security of our lives; degrade the functionality of flood-control and water-utilization facilities; and reduce the functionality of rivers, mountain streams, and seacoasts as natural environments for plants and animals to live and grow in and as places for activities that bring humans into contact with nature.

In particular, problems associated with sediment transport that are occurring in different areas of river basins, including mountains and piedmonts, alluvial fans, plains, estuaries, and coasts, may not be solved simply by implementing countermeasures to the problem in individual areas such as erosion control facilities, dams, rivers, and coasts.

In such cases, we must not limit the measures to each individual area; instead, we must identify the entire process of sediment transport from the mountain and piedmont to the estuary and coast through the concept of a sediment transport system. We need to investigate and examine the entire system, comprehensively understand sediment transportation, and plan and implement countermeasures.

On the basis of the characteristics of each river and seacoast, comprehensive sediment control as part of national land management should aim to properly control sediment production and adjust sediment runoff in the entire sedimentary system, which has both temporal and spatial expansion. Thereby, it will be able to prevent disasters caused by sediment transportation, conserve the ecological system and landscapes of rivers and seacoasts, utilize open spaces along the rivers and seacoasts, and realize a rich and vital society.

Since it is important in the implementation of comprehensive sediment control to understand the characteristics of sediment transportation in the entire sedimentary system and improve the accuracy of research and prediction methods, sediment transportation over the entire sedimentary system should be monitored.

Chapter 2 River Planning

Section 1 The Basics of River Planning

1.1 General Overview

The aim of river planning should be to achieve a harmonious balance between flood control, water utilization, and environmental function and should also consider comprehensive sediment management. River planning should also consider the quality of the various data used, such as hydrological data, including rainfall and flow rate, and environmental data.

Explanation

This chapter covers the basic elements of planning for flood prevention, appropriate use of rivers, maintenance of the designated functions of river water, and improvement and conservation of the river environment. These issues should be considered from the viewpoints of flood control, water utilization, and the environment as part of the establishment of a basic policy for river improvement and river improvement plans, as stipulated in the River Law.

In this chapter, the descriptions of river planning have been divided into "Basic Flood Prevention Planning", "Basic Appropriate Use of Rivers and Maintenance of Normal River Water Function", and "Basic Improvement and Conservation of the River Environment" for purposes of convenience. However, flood control, water utilization, and environmental functions are in reality closely interrelated, and it is not possible to completely separate them in practice. Comprehensive sediment management is also very important along with river management, including maintenance, flood prediction, and facility operation. In practice, river planning needs to be undertaken so that these various functions are comprehensively reinforced.

The following are some of the more important considerations when undertaking river planning:

- The present state and historical changes to the natural environment of the basin
- The present state, historical changes, and future outlook for land use and the social environment of the basin
- History of disasters and measures taken
- Achieving the required level of flood control
- Measures for mitigation of damage when the design flood level is exceeded
- Comprehensive sediment management
- The present status and future prospects for water utilization
- Securing of a healthy water cycle system
- Maintenance and management of rivers
- Conservation and restoration of the natural environment
- Maintenance and formation of an aesthetically pleasing river landscape
- Maintenance and formation of places for human interactions with rivers
- Linkages between river management and regional development
- Economic rationality..

River planning requires various data. In flood prevention planning, for example, requires data on rainfall, flow rates, water levels, floodmarks, sea levels, cross-section surveys, to name just a few. Before these data are used, their accuracy should be thoroughly confirmed by a method such as comparison with the results of observations in nearby areas. If necessary, the data should be corrected.

1.2 Fundamental river management policy and river improvement plans

The fundamental river management policy for a broad geographic area (country, province region), prescribe the long-term policy for river improvement and the basic types of improvement planned for each river system while taking into consideration the entire balance across the region and the characteristics of the individual rivers and their basins.
A river improvement plan, on the other hand, should prescribe the specific improvements to be carried out over a period of about 20 to 30 years in accordance with the stipulations of the fundamental river management policy while taking the needs of the inhabitants of the river basin into consideration.

Explanation

The implementation of a river improvement project involves first setting the goals to be achieved and then implementing the measures aimed at achieving these goals. Since river improvement requires enormous cost and time, the general practice is to set medium-term goals with staged implementation while maintaining good of the level between different river systems, rivers, etc. It is not just the rivers themselves that change in response to natural processes; the social situation within the river basin also continually changes over time, leading to direct influences on the river and changes in the river-related needs of the local residents. Therefore, it is impossible to comprehensively determine at any given time the specific improvements that will reflect the long-term goals or the specific procedures and timing needed to achieve these goals. Consequently, a target planning period should be set that is appropriate for achieving the immediate needs and providing local residents of a sense that tangible results will occur in a realistic timeframe. After choosing the planning period, a river improvement plan that defines the medium-term improvement goals should be set in accordance with the fundamental river management policy and its long-term goals.

The following items are to be described in the fundamental river management policy:

1. The basic policy on comprehensive conservation and utilization of rivers in the given river system
2. Basic river improvement
    a. Design flood and flood diversion to river channels and flood control facilities
    b. Design flood discharge at major locations
    c. Design high water levels at major locations and associated river width
    d. The flow discharge needed to maintain normal functions of river water at major locations.

The following items are to be described in the river improvement plan:

1. The goals of the river improvement plan
2. Information on the implementation of river improvements, including:
    a. The purpose and types of work, locations, and an outline of the function of any river management

facilities to be built

b. The location, purpose, and type of any required river maintenance.

As described above, a river improvement plan identifies the specific components of a river's improvement. In executing the actual improvement work within cost and time constraints, it is essential to determine the order of the works and coordinate the initiation and progress of all projects. To this end, the following should be considered:

1. The basic unit of a river improvement plan is a section of river in which a series of river improvement works is to be implemented.
2. Generally, the planning period is set at around 20 to 30 years, which is regarded as the time required to complete a set of river improvement works for a particular section. However, in cases where there are uncertainties about specific improvements (e.g. if an extended period is needed for research and study), then these improvements should be omitted from the plan to enable a shorter planning period to be adopted. Alternatively, the issues of uncertainty should be specified for further investigation and the plan reviewed at a later time after they have been clarified.
3. The plan should be periodically reviewed and revised as necessary with respect to changes in the circumstances surrounding the subject river, including regional planning objectives.
4. Reviewing the river improvement measures should consider the allocation of funds to allow the plan to be realized within the planning period and to be compared with alternatives.
5. The river improvement measures should be described so that the need for them and effects they will bring are clearly presented.
6. In deciding the composition of each item of river improvement works, the need to minimize future follow-up work should be considered as much as possible. However, because a particular improvement work may be urgent, and because there is also a need for the facility to be durable, future follow-up work may be unavoidable.
7. The maintenance plan identifies the maintenance tasks to be systematically undertaken, not just one-off and urgent maintenance works. Items that are needed for river monitoring, such as observations and surveys, should also be included.
8. The river improvement plan should also describe any tasks that are needed as preconditions for river improvement.

Section 2 Basics of Flood-prevention Planning

2.1 Overview

A flood prevention plan first needs to adopt a flood hydrograph (hereinafter referred to as design flood). This design flood forms the basis of the plan at design control points and is adopted with the aim of ensuring the desired flood behavior modification to prevent or mitigate river flooding disasters.

For this reason, the flood prevention plan should be prepared in such a way that the facilities to be built from the design flood are technically and economically well balanced throughout the river system and achieve the

desired level of functionality.
In the preparation of a flood prevention plan, it is necessary to comprehensively examine the functions of the river system, including flood control, water utilization, and environmental functions. It should be noted that the plan does not aim to control the maximum possible flood in the subject river. The plan aims to not just control the design flood but also to be able to deal with the occurrence of a flood that exceeds the design flood (hereinafter referred to as excess flood), wherever necessary.
The fundamental river management policy should specify the peak flow of the design flood at design control points, deployment of river channels and flood control facilities, and the design flood discharge at major locations. The river improvement plan should specify target years for staged goals to be achieved and should aim to prevent flooding within a certain magnitude and, where necessary, mitigate damage from floods that exceed the design flood. Also, the plan should emphasize the efficient use of existing facilities and non structural measures and consider countermeasures to be implemented by communities in the river basin.

Explanation

In the preparation of a flood prevention plan, coordination between the plan and other river plans and facility plans for the subject river and its basin is necessary. In general, for example, this means coordination between the river course plan and the erosion and sediment management plan, between the flood control plan and the water utilization plan, and between the river course plan and the environmental conservation plan, etc.
A flood prevention plan should be technically and economically appropriate and ensure that sufficient effects are produced.
Technical and economic consideration should be given not to concentrate the damage caused by excess floods to the greatest extent possible. Consideration should also be given to ensuring the availability of appropriate countermeasures in the event of an excess flood by elucidating the damage that such a flood would cause to affected regional communities.
If it is sufficient for the purpose of the plan, the design flood could be defined only by peak discharge instead of defining design hydrographs.

2.2 Method of determining the design flood

Although several different methods exist for determining the design flood, the most common, and the one that should be used as standard, is based on rainfall analysis.
The design flood should be determined for each design control point.

Explanation

The design flood is estimated from the probability of occurrence of a flood of the scale represented by the hydrograph, i.e., the occurrence probability. The occurrence probability indicates the degree of security adopted for this flood prevention plan, or the safe level of flood control: the smaller the occurrence probability, the greater the degree of security.
However, a flood hydrograph itself is not necessarily useful for calculating the occurrence probability. In many

cases, a flood hydrograph, as used for statistical analysis from peak flow or total volume, presents difficulties such as a lack of precision because of data shortages, and the need for complex calculations.

Therefore, the method that focuses on the rainfall that causes the flood involves selecting a subject rainfall level with a probability of excess corresponding to the established safe level of flood control. A hydrograph is then plotted from this subject rainfall. This method should be used as the standard approach, though in some cases, a method more appropriate to the subject river may need to be adopted.

While a number of flood hydrographs may be calculated using a flood runoff model based on the subject rainfall, the hydrograph that is used as the basis of the flood prevention plan represents the "design flood". The selection of a design flood requires comprehensive review for setting an appropriate peak flow that corresponds to the scale of the design. Since the design flood serves as the basis for the flood prevention plan, the flood hydrograph must be one that has not been affected by any artificial manipulation such as flood control. The design flood is not necessarily the one with the maximum peak flow or maximum total flow among the calculated flood hydrographs.

Incidentally, the phrase "subject rainfall" is used here rather than the more conventional phrase "design rainfall". This avoids the interpretation of "design rainfall" as meaning only one type of rainfall event that is used to determine the design flood. As described in Section 2.7 of this chapter, a design flood can be produced by a series of rainfall events, and such a group of rainfall events that are used to determine the design flood are referred to as the "subject rainfall".

2.3 Subject rainfall

The subject rainfall is selected for each design control point. Subject rainfall is represented by three elements: the amount of rainfall, the temporal distribution of the rainfall, and the regional distribution of the rainfall.

Explanation

This section shows the elements of the subject rainfall as used in the standard method for determining a design flood.

The concept of selecting subject rainfall will be described in Section 2.6 of this chapter.

2.4 Design reference point

The design control points should be chosen to have sufficient hydrological data available, should serve as locations for hydrological and hydraulic analyses, and should be closely related to the overall plan. The design control points should be set wherever necessary for the plan.

Explanation

Design control points are used as points at which to evaluate the target safety level. Suitable locations are river gauging stations or dams or other major flood control facilities that can serve as a basis for hydrological analysis. Fig. 2-1 shows candidate reference points: a gauging station at A on the main river course, gauging stations on tributaries B and C, and dams D and E.

The scale of the subject rainfall can differ from point to point, and if there are different facilities subject to the plan differ at the same location, then the subject rainfall may differ for each set of facilities.

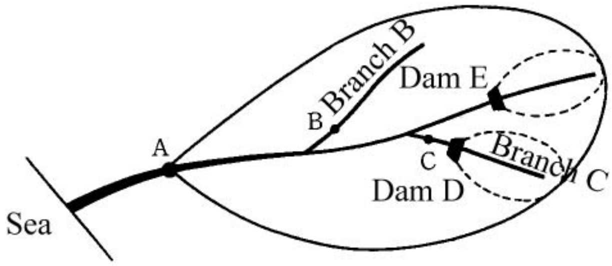


Fig. 2–1

2.5 Determining the design scale

2.5.1 Scale of plan

In determining the planning scale, the importance of the subject river should be emphasized, and the actual damage caused by past floods, economic effects, and other factors should all be taken into consideration.

Explanation

The planning scale refers to the level of safety against flood disasters to be provided in the area affected, and it is desirable that a good balance be maintained between the upstream and downstream areas, as well as between the main stream and the tributaries, depending on the importance of each river. This balance also needs to be viewed from a national perspective.

The importance of the river should be defined from the purpose of the flood prevention plan and in consideration of various elements, such as the extent of the river basin, the social and economic significance of the subject region, the quantity and quality of the assumed damage, and the history of past disasters. Approximate references for determining the scale of the subject rainfall when rivers are categorized into importance classes A, B, C, D, or E are shown in Table 2–1.

For estimated damage, refer to Economic Research in the Research volume.

Generally, a river that has major sections of class I river is designated in importance as class A or B; one that has minor sections of class I urban river and class II urban river is designated as class C. Classes D and E are generally designated class ‘general’ rivers, depending on their importance.

For regions that have suffered enormous damage in the past, it is generally undesirable to determine the planning scale without considering the prior catastrophic floods. In such cases, a plan is usually set up to stabilize people’s livelihoods such that future floods of the same scale will not cause disasters.

However, in this case, there is also a need to consider the balance between upstream and downstream areas and the balance between the main stream and tributaries.

Once the design scale has been determined, the subject rainfall, which is necessary for engineering design, can be selected. The subject rainfall is characterized by the amount of rainfall, temporal distribution, and regional distribution; the scale of the subject rainfall, however, is generally evaluated by its return period.

Therefore the return period of such subject rainfalls does not necessarily correspond to the return period of peak discharge.

However, since the return period of the peak discharge of the design flood has an important meaning in a flood prevention plan, if there is a significant difference in return period may arise between subject rainfall and peak discharge, it will be necessary to clarify the relationship and consider the adoption of some other method to determine the planning scale.

Table 2–1 Importance of river and planning scale

Importance of river	Planning scale (Return period in year of subject rainfall) *
Class A	Over 200
Class B	100–200
Class C	50–100
Class D	10–50
Class E	Below 10

* Inverse of the annual probability of excess

2.5.2 Consistency of the scale of plan within the same river system

When setting flood prevention plans within the same river system, consideration should be given to maintaining sufficient consistency between the upstream and downstream areas with regards to the planning scale, as well as between the main stream and tributaries.

Explanation

The purpose of a flood prevention plan is to prevent floods of the design scale.

Maintenance of consistency does not necessarily mean that the design scale will continue between the upstream and downstream areas or between the main stream and tributaries. Especially, when two or more design control points have been determined within the same river system, there will usually be no correlation between the subject rainfalls in terms of the amount and duration of rainfall, etc. Simply using the same planning scale for both the upstream and downstream areas or for the main stream and tributaries will, in many cases, endanger the downstream or mainstream regions if an excess flood occurs. Therefore, the appropriate scale for the particular section of river should be taken into consideration to achieve consistency in the level of protection.

In addition, consideration should be given, wherever necessary, to ensuring that the damage caused by an excess flood will be distributed as much as possible and will not be excessively concentrated on specific areas.

2.6 Selection of subject rainfall

2.6.1 Determining the amount of subject rainfall

The amount of subject rainfall should be determined by setting the planning scale in accordance with the stipulation in Section 2.5.1 of this chapter, and also by setting the duration of rainfall.

2.6.2 Review of past floods

The review of past floods should include the characteristics, duration, and spatial distributions of the amounts of rainfall that caused them; their water levels and hydraulic and hydrological data, such as rates of discharge; and the flood situation and the reality of damage, etc.

Explanation

Data on the rainfall, water level, and flow discharge associated with past floods are critical for hydraulic and hydrological analysis. To clarify the temporal and spatial distributions of rainfall, it is necessary to collect as many hourly rainfall data as possible for major locations within the river basin.

Actual measurements of flow discharge at major locations is desirable. If unavailable, estimates should be obtained using an appropriate method, such as by inverse calculation from floodmarks. The highest possible accuracy is required in estimating the impacts of flooding and water retardation from particular flow discharges.

The characteristics of past flooding and damage it caused should be thoroughly investigated because this will be of prime importance in judging the effects and significance of the project.

2.6.3 Duration of subject rainfall

In determining the duration of the subject rainfall it is necessary to consider the size of the river basin, the properties of the rainfall, the pattern of flood runoff, the type of project facility, and any difficulties in accessing past data etc.

Explanation

The duration of the subject rainfall should be based on the size of the river basin, the duration of flooding, and the cause of rainfall (typhoon or front). The type of counter measures that would be studied should also be considered.

Since the data necessary to determine rainfall duration are not always available, the duration is often set at 1 to 3 days for the purposes of statistical analysis and other reasons.

Also, in the case of a river where a flood can travel from the most distant point of the basin to the river within several hours, it is necessary to separately examine those rainfall events whose durations dominate the size of the peak discharge of the flood.

2.6.4 Determining the time and areal distributions of the subject rainfall

The temporal and spatial distributions of the subject rainfall should be determined for a considerable number so that each subject rainfall would have equal amount of rainfall to that of planning scale determined in Section 2.5.1 of this chapter.

It should be corrected if significant inconsistency arises from simply extending the distributions.

Explanation

Once the total rainfall for the subject rainfall is given, the remaining two elements—that is, the temporal and spatial distributions—should be determined to define the subject rainfalls.

After having total volume of the subject rainfall, you should determine temporal and spatial distribution of the subject rainfalls.

In general, the following two methods are available.

One method is to clarify the statistical or meteorological relationships between these three elements (i.e. the amount of rainfall, temporal distribution, and spatial distribution) and determine the temporal and spatial distributions for given rainfalls from these relationships.

Another method is to determine the amount of rainfall and then create the temporal distribution and spatial distribution by simply expanding or contracting some past rainfall patterns. Unless they are regarded as being unlikely to occur in consideration of the statistical relationships between these elements, they will be adopted. Since it is usually simple and easy to understand, the latter method is used here. In selecting past rainfall events, care must be taken that rainfall events that have caused severe floods or have high recurrence patterns in the basin are not excluded. The number of rainfall events to be selected varies depending on the length of time for which the data have existed; the maximum extension rate is set to about 200% in many cases.

The rainfall patterns that have extensive differences in spatial distribution or have high intensity during a part in temporal distribution may arise remarkable discrepancies because rainfall intensity during the hours that dominant the peak discharge tends to be extremely high in such rainfall patterns.

The following examples are considered as specific processing methods:

1. If extension of rainfall that has extensive differences in spatial distribution causes rainfall in some parts of the basin to be significantly large, and the return period of that rainfall is significantly different from the return period of the design scale, then the expanded rainfall of that rainfall pattern should be excluded from the subject rainfalls, since its inclusion is deemed inappropriate.
2. If extension of a pattern where short duration, high intensity rainfall causes the return period of rainfall intensity within the duration that is predominant over the peak discharge of a flood to be remarkably different from the return period of the design scale, then the extended rainfall of that rainfall pattern should be excluded from the subject rainfalls since its inclusion is deemed inappropriate.
3. Subject rainfalls for the rainfall patterns described in 1 and 2 above should be adopted after correction of the spatial and temporal distributions as well as any remarkable differences in return period.

2.6.5 Adjustment of the actual rainfall duration against the subject rainfall duration

If the actual rainfall duration selected in Section 2.6.4 differs from the subject rainfall duration, then the following adjustment is to be made, depending on the duration:

1. When the actual rainfall duration is shorter than the subject rainfall duration

Leave the actual rainfall duration as it is, and extend only the amount of rainfall to that of the subject rainfall. In this case, however, if any inconsistency as described in Section 2.6.4 arises, correction should be made within that range.

2. When the actual rainfall duration is longer than the subject rainfall duration

As a rule, the solution described in 1 above should be adopted. However, if the amounts of rainfall after extension have become fairly large compared with the amount of subject rainfall, then, as a rule, extend the amount of rainfall within a time equivalent to the duration of the subject rainfall only, and use the actual rainfall for any rainfall before that time.

Explanation

It is extremely rare for the actual rainfall duration selected in Section 2.6.4 of this chapter to agree with the subject rainfall duration. However, even the data used for determining the design scale of the subject rainfall in Section 2.5.1 normally do not have rainfall durations that match the subject rainfall durations; therefore, normally, it is not necessary to make any adjustment at all. On the other hand, if the actual rainfall duration is much longer than the subject rainfall duration, and the amount of rainfall after extension is much greater than that of the subject rainfall, then not making any adjustment will result in inconsistency.

In this case, as a rule, with the part that is identified as the main constituent of the series of rainfall events positioned at the center, the amount of rainfall within the time corresponding to the subject rainfall duration should be extended so that it equals the amount of the subject rainfall, and the actual rainfall should be used as it is for preceding rainfall that continues to the subject rainfall (Fig. 2–2).

Various other adjustment procedures may be possible. However, because in river planning there are many cases in which comparison with other rivers is required, we have decided to propose this procedure as a standard. When the construction of a detention reservoir is anticipated, however, it is necessary to take into consideration the series of rainfall events, including rainfall before and after.

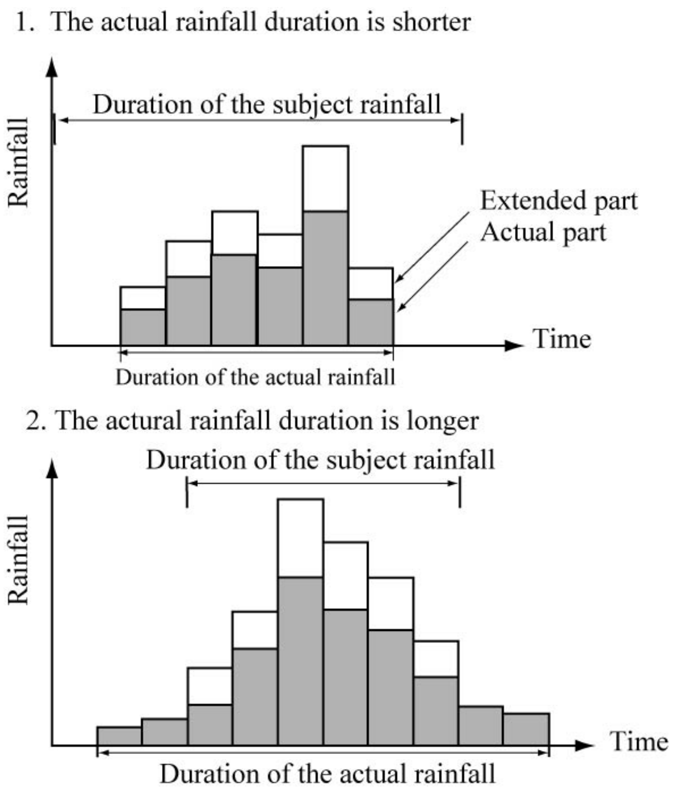


Fig. 2–2 Adjustment of rainfall durations

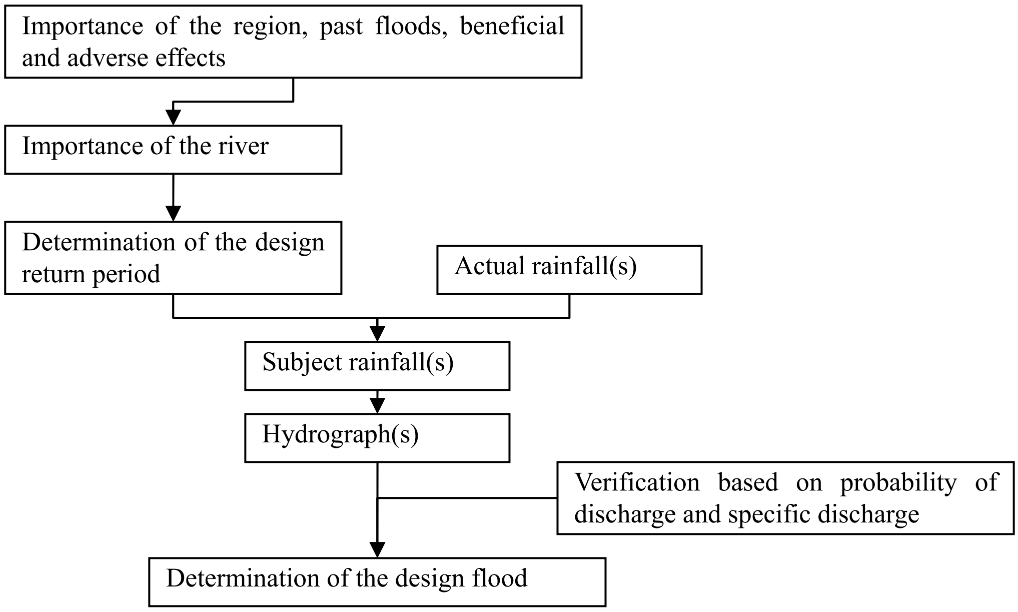


Fig. 2–3 Determination of the design flood

2.7 Determination of the design flood

2.7.1 Determining the design flood

The design flood should be determined from flood hydrographs plotted for the subject rainfalls selected in Section 2.6 of this chapter. An appropriate flood runoff model will be used, and there will be comprehensive consideration of the properties of past floods, project facilities, etc.

Explanation

Since the subject rainfalls have already been selected, it is easy to calculate the hydrograph of a flood using an appropriate runoff model, but a careful examination is needed to select the hydrograph that will be used as the basis for determining the design flood.

The process of determining the design flood should be as shown in Figure 2–3.

To select (a group of) subject rainfalls, the spatial and temporal distribution should be examined as described in Section 2.6.4 of this chapter. The rate of extension should be about 200% in most cases.

Flood control facilities such as dams and flood control basins should be ignored in the hydrograph calculations, and for water utilization dams such as hydroelectric storages, operating rules for flood conditions should be taken into consideration.

In most cases, since inappropriate rainfalls have already been rejected from the examination of spatial and temporal distributions, etc., the hydrograph that shows the maximum discharge among the calculated hydrographs in the group should be selected to give the peak discharge of the design flood.

When there is a sufficient record of discharge data, a discharge probability should be used. For small and medium-sized rivers, the peak discharge of the design flood should be verified by a method such as the rational formula. It is also necessary to use the unit discharge to check the relative balance between the main stream and tributaries, between the upstream and downstream, climate characteristics, and other rivers of similar design scale.

Another method of determining the design flood includes determining the peak discharge for the design scale by evaluating the probabilities of rainfall of different magnitudes along with their spatial and temporal distributions based on extensive amounts of accumulated data.

2.7.2 Conversion of subject rainfalls into a flow discharge

A runoff calculation method that is best suited to the characteristics of the subject river should be used to convert the subject rainfalls into a flow discharge. The rational method can be used for rivers in which flood storage does not have to be taken into consideration.

Explanation

One of the various calculation methods for converting rainfalls into flow discharge that can adequately reflect the runoff characteristics of the subject basin should be selected. Runoff calculation methods include, among others, the unit hydrograph method and the storage function method. The rational method is widely used where storage phenomena are barely observed in the river channel or basin, where there is no need to take storage phenomena into consideration, and where there are no construction plans for dams, flood control basins, or the like.

For details of these runoff calculation methods, please refer to the Technical Criteria for River Works (Draft) Research.

2.7.3 Determining constants for the flood runoff model

When determining constants for the flood runoff model being used to convert the subject rainfalls into a flow discharge, the following factors need to be considered:

1. Possible difference between the actual and design flood scales
2. 2. Possible changes in the basin conditions since the flood through land development, afforestation, deforestation, etc..

Explanation

Since parameters for the flood runoff model are usually obtained from actual data from smaller scale floods, care must be taken to avoid irrational results when determining them.

In determining the constants, sufficient consideration must be given to possible changes in basin conditions that that may have occurred since the time of the actual flood, such as those caused by land development. In particular, the runoff ratio needs careful examination since it can change considerably in response to the state of the basin and can greatly influence the flood runoff volume as well as the flood peak discharge.

The following default values may be used for the runoff coefficient when using the rational method, and inlet time may be used to calculate the time of concentration (time for the flood to travel from the most distant point of the basin to the point in the river channel under consideration). For details about formulas for determining the time of concentration, please refer to the Research volume of Technical Criteria for River Works (Proposal).

<Runoff coefficient>

Densely built-up area	0.9
General built-up area	0.8
Field and plain	0.6
Paddy field	0.7
Mountain	0.7

<Inlet time>

Mountainous river basin	2 km^2:	30 min
River basin with very steep slopes:	2 km^2	20 min
Area with sewerage system	2 km^2:	30 min

2.7.4 Consideration of landside waters

When inner waters are deemed to have a great influence, that influence should be taken into consideration.

Explanation

In the downstream part of a river or in a basin, inner waters may have a strong influence over the peak discharge of the design flood.

In such a case, the existing inner water drainage plan should be taken into consideration. In addition, even if there is no specific drainage plan currently available, an appropriate amount of drainage discharge should be added to the calculated design flood, as required, taking into consideration the future development situation of the subject area and referencing drainage plans, etc. for other similar areas. Methods for this purpose include one that calculates the drainage discharge from an inner water analysis model, and one that uses a unit discharge of approximately 5 m3 s–1 km–2 for an urban area and approximately 2 m3 s–1 km–2 for a general area.

2.8 Design flood discharge

2.8.1 Design flood discharge

In flood-prevention planning, the high water discharge to be used as the basis for river channel and dam planning for major locations should be determined by rationally routing the design flood through river channels, dams, etc. This is called the design flood discharge.

Explanation

For river channel and dam planning, the high water discharge at design control point is of primary importance. However, the flood control capacity of a dam is influenced by the shape of the hydrograph, the capacity of the dam that could be built, the rules of operation of the dam, etc. in addition to the high water discharge. Therefore these elements must be thoroughly examined when determining design flood discharge. The runoff discharge at the design control point and other major locations is calculated from one or more design floods and varies depending on the channel characteristics and hydraulic conditions such as the capacity of the dam, etc. Rational distribution of the design flood to river channels and dams means the distribution of these flow volumes to channels, dams, etc. while considering consistency between upstream and downstream and between the main stream and tributaries and examining the items described in Section 2.8.2 below.

2.8.2 Items to be examined in determining the design flood flow discharge

When setting the design flood discharge for a river channel, dam, flood control basin, etc., it is important to fully consider each of the following:

1. Study on installation of flood control facilities such as dams, regulating reservoirs, and flood control basins from technical, economic, social, and environmental conservation points of view.
2. Study on improvement of current river channels and distribution to cutoff channels, discharge channels, and tributaries, etc. from technical, economic, social, and environmental conservation points of view.
3. Issues concerning the coordination of current and future regional development plans along the river and other projects related to the river.
4. Perspectives and policies on strategies to counteract future increases in flood discharge in areas subject to increasing urbanization.
5. Technical, economic, and social measures for dealing with excess floods.
6. Evaluation at each phase of project implementation.

1. 7. The difficulty of operation and maintenance of the subject facilities.

Explanation

The items listed above need to be thoroughly examined before determination of the design flood discharge to be used as the basis for each river facility plan.

2.9 Measures against excess floods

For rivers that are anticipated to cause serious damage in floods exceeding the design level, measures to mitigate the effects of such excess floods should be planned.

Explanation

River embankments are constructed or improved to withstand the normal action of flowing water below the design flood level (or design storm surge level if applicable). However, since floods are normally caused by natural rainfall, there is always some probability that a flood exceeding the design flood discharge may occur. If such an excess flood occurs, river embankments may be destroyed, resulting in enormous damage. In particular, the failure of river embankments that protect areas possessing high population density, extensive infrastructure,, or central administrative functions will not only take a heavy toll in the area but will also cause great damage to the entire country, both socially and economically.

For this reason, the consequences of floods exceeding the design scale should be considered when establishing a fundamental river management policy and river improvement plans. Construction of embankments with higher standards of protection than for the design flood should be planned for particular river sections if the predicted damages from excess floods are deemed unacceptable.

Section 3 Basics of Appropriate Utilization of Rivers and Maintenance of Normal River Water Function

3.1 Overview

The basic items associated with the proper utilization of rivers and the maintenance of normal river water function should be aimed at proper management of rivers. They should serve as a basis for determining the flow discharge necessary to maintain the normal function of river water and for establishing a policy for securing this flow discharge while ensuring consistency with flood control functions.

Explanation

For appropriate utilization of rivers and maintenance of normal river functions, the basic aim is to manage rivers to ensure that they are kept in their normal condition as part of a comprehensive river management strategy.

The flow discharge necessary to maintain the normal function of river water should be determined from the current uses to which the river water is put, the present condition of the river environment and the natural and social environments of the river basin and their historical contexts.

The formulation of policies for securing the discharge levels needed to maintain normal river functions should fully consider structural measures such as dams and non structural measures such as rationalization of diversion of flow and more effective use of existing facilities. The policy should ensure that the flow discharge needed to maintain normal river functions can be secured for at least up to a 1 in 10 year drought. It is also desirable to develop measures for droughts that may exceed this design scale.

3.2 Normal flow discharge

There are two types of flow discharge to be determined. The first is the flow discharge determined in total consideration of water functions such as navigation; fisheries; tourism; maintenance of clean river water; prevention of salt damage; prevention of river-mouth clogging; protection of river management facilities; maintenance of groundwater levels, landscape values, and ecosystems; and the securing of opportunities for human interactions with the river. This discharge is hereinafter referred to as "maintenance flow discharge". The second is the flow discharge necessary for water utilization downstream of the point for which the maintenance flow discharge has been determined (hereinafter referred to as "water utilization flow discharge"); this discharge is determined at a point that serves as the reference point for appropriate river management. The normal flow discharge, if necessary, should be determined for each of the river reach represented by annual fluctuations in the maintenance flow discharge and water utilization flow discharge.

Explanation

The flow discharge required to maintain the normal functions of the river water should be secured throughout the year, and it should be determined in consideration of fluctuations in river discharge, in addition to other factors.

For the main stream and major tributaries, one or more reference points for monitoring normal flow discharge to ensure appropriate low water management. It is desirable to select reference points at which sufficient hydrological data have been obtained and which have good flow discharge correlations with other flow discharge observation points under normal river conditions, or at points for which the relationship between upstream and downstream flows is clearly understood and which is close to the where the river water is utilized.
The normal flow discharge should be determined by investigating the water balance between these reference points from data on the inflow and quantity of water intake of the subject river; the value chosen for normal flow discharge should satisfy both the maintenance flow discharge and the water utilization flow discharge.
The normal flow discharge should be determined for each of the river reach determined in consideration of the annual fluctuation patterns of both the maintenance flow discharge and the water utilization flow discharge.

3.3 Determining the maintenance flow discharge

The maintenance flow discharge should be determined for each of the different sections of the river, divided from the similarity of their properties.
The maintenance flow discharge, if necessary, should be determined for each of the river reaches,.

Explanation

The maintenance flow discharge should be determined in total consideration of river functions such as navigation; fisheries; tourism; maintenance of clean river water; prevention of salt damage; prevention of river-mouth clogging; protection of river management facilities; maintenance of groundwater level, landscape values, and ecosystems; and the securing of opportunities for human interactions with the river. Among these conditions, the needs for tourism are considered to be largely satisfied if conditions such as landscape values and river and navigation are maintained. The securing of opportunities for human interactions with the river are considered to be basically satisfied if the flow discharge, determined from such conditions as river and navigation, fisheries, and maintenance of clean river water, landscape values, and ecosystems, is maintained. Consequently, the maintenance flow discharge can often be determined by comprehensively taking into consideration the above-mentioned nine conditions, with the exception of tourism and the securing of opportunities for human interactions with the river.
In determining the maintenance flow discharge, it is desirable to also consider fluctuations in flow discharge.

1. River and navigation

River and navigation was originally carried out within the context of natural fluctuations in river water level that would occasionally cause suspension of service in times of drought. Even if river and navigation services are temporarily suspended when a drought occurs, they can be substituted with alternative services such as land transport and can return to normal operations as soon as adequate water levels are restored.
However, depending on the amount of water traffic and availability of alternative means, river and navigation can play an important role in physical distribution and public transport. Also, the public need for river and navigation is high where it is associated with tourism or has historical significance. In such cases, it may be

necessary to specify a target and secure a certain flow discharge (width of water surface and depth of water) based on it.

2. Fisheries

The flow discharge necessary for fishery operations can usually be satisfied by the flow discharge necessary for maintaining ecosystems. However, further examination will be necessary in the case of rivers for which special conditions, such as for laver (nori seaweed) cultivation, are needed.

3. Maintenance of clean river water

There is a need to control the deterioration in water quality that occurs as a consequence of reductions in water volume. Essentially, the quality of the river water should be maintained by implementing pollutant source-control measures in the river basin. Therefore, reduction of the pollutant load in the basin should be given first priority in determining the necessary flow discharge. However, since it may be difficult to secure high water quality through pollutant control alone, it is necessary to also consider the possibility of a measure for increasing the flow discharge.

4. Prevention of salt damage

The flow discharge necessary to prevent salt damage should be determined such that the effects of saltwater intrusion on river fisheries and ecological systems are minimized, as are the effects of an increase in the salinity of water and groundwater taken from the river for domestic water supply and agriculture.

5. Prevention of estuary clogging

A certain flow rate should be ensured for rivers where the estuary is prone to clogging or is expected to be subjected to clogging in the future.

6. Protection of river management facilities

It is necessary to secure a flow discharge sufficient to prevent the degradation of wooden facilities (e.g. revetment foundations and pile hurdles) because of water level reductions caused by decreases in flow discharge.

7. Maintenance of groundwater level

It is necessary to secure an adequate level of flow discharge if a reduction in river flow discharge causes a remarkable reduction in groundwater level and directly and extensively influences groundwater recharge.

8. Landscape

The flow discharge necessary for maintenance of landscape values is to be determined such that the landscape is visually satisfying. Drought-affected river landscapes are a natural phenomenon, but a permanently degraded river landscape due to low flows caused by large-scale water intake is undesirable. In particular, it is necessary to secure adequate flow discharge to maintain widely popular river landscapes that are valuable for tourism, scenic values, or holding special events.

9. Status of ecosystems

The flow discharge should allow maintenance of river ecosystems. Diverse ecosystems are formed in rivers with fluctuating discharge. Although the occurrence of natural droughts is an element of this fluctuation, a reduction in flow discharge through large-scale artificial intakes can cause a drastic deterioration in the habitat of animals and plants.

It is particularly important to secure a level of flow discharge that will maintain habitat in riffles, inlets, etc., which are vulnerable to drastic reductions in flow discharge.

In addition to the above items, if there are other items that need to be taken into consideration as measures affect adversely the present condition of the subject river, then those items should also be examined.

Since the elements described above change along the river course because of changes in natural and social factors, it is necessary to divide the subject river into multiple sections of relatively uniform conditions and determine the maintenance flow discharge for each section based on the prevailing conditions.

Classification of river sections should be conducted by comprehensively examining various factors, such as the riverbed configuration, tributary inflow, condition of the river channel, ecosystem conditions, river water quality, and river utilization.

The items needed to maintain the flow discharge may differ for each river reach of each particular river. For this reason, in determining the maintenance flow discharge, the necessity for river reach division should be examined. If necessary, river reach division taking into consideration the reach-specific pattern of necessary flow discharge by item should be performed, and the maintenance flow discharge should be determined for each river reach.

Facility installation or improvement, etc. may be a possible measure in the river section and ensuring a particular level of flow discharge may then not be the best river management strategy. Therefore, the possibility of such facility installation or improvement should be taken into consideration when determining an appropriate maintenance flow discharge.

3.4 Determining the water utilization flow discharge

> The water utilization flow discharge should be determined for each of the locations selected as appropriate for the actual situation of river water utilization. This discharge should be determined for each of the sections determined by river reach division in consideration of the annual water utilization pattern, as required.

Explanation

The water utilization flow discharge is the level of river flow discharge necessary for occupancy of river water. It should be determined from the water levels and volumes necessary at each intake location. To maintain water levels high enough for the intake may require the installation of weirs or improvement of intake facilities, etc.

The flow discharge to be ensured for the subject river should consider licensed water rights and customary water rights. Both licensed water uses and customary water uses should be thoroughly investigated to clarify the purpose of use, water volume used, period of use, etc.

The water utilization regulation needs to be reviewed at appropriate intervals in response to changes in actual water utilization.

In determining the water utilization flow rate, the intake volumes and locations for various water uses should be longitudinally pigeonholed to select appropriate locations and determine the water utilization flow rate for each location. If the need arises, river reach division should be conducted in consideration of the annual water utilization pattern, and the water utilization flow rate should be determined for each of the periods.

Section 4 Basics of Improvement and Conservation of the River Environment

4.1 Overview

The fundamentals of improving and conserving the river environment involves: the conservation and restoration of a sound habitat for animals and plants; the maintenance and enhancement of a good landscape; the creation and maintenance of places for enabling human interactions with the river; and the preservation of water quality.

Explanation

With the modern demand for affluent, comfortable, lives in a high-quality environment, rivers are increasingly expected to provide pleasant riparian leisure space and healthy habitat for plants and animals. In addition to providing flood control and supplying water, rivers are also seen as important elements of regional landscapes, nature, and culture. For this reason, it is necessary to define the fundamental elements of "improving and conserving the river environment".

The basic items associated with the improvement and conservation of the riverine environment need to be examined, together with the basic items associated with flood-prevention plans (Section 2) and the basic items associated with appropriate river use and the maintenance of normal river water functions (Section 3).

4.2 Conservation and restoration of a healthy environment for plants and animals

In river improvement and management, efforts should be made to maintain the biotic communities and habitat that will benefit the river in the future, taking into consideration the present status and past changes in biotic communities and in the habitat of the river.

Explanation

Conservation and restoration of habitat is important for maintaining diverse ecosystems, sustainable utilization of biotic resources, and opportunities for human interactions with nature. A river changes its physical form as it flows downstream and eventually reaches the estuary; its waters also change under the influence of various elements in the basin. From their source to the estuary, rivers change in character because of differences in topography, soil, water, exposure to sunlight, etc. in different parts of the river and the different river habitats such as the acquatic environment, the water’s edge, sand bars, and so on. Diverse communities of plants and animals live and grow in these diverse environments. It is necessary to fully understand the vital role that rivers play in conserving the diversity of biotic communities, providing regionally significant ecosystems in a healthy condition.

To this end, it is important to determine which biotic communities and habitats are suitable for the river. There is a need to focus on the objects and lives that are scientifically significant or rare—those that are typically seen in the river, highly dependent on the river, and maintained by the dynamism of the river, and those that are indicators of continuity between upstream and downstream. There is also a need to consider the environments that are atypical of the river, and to take into consideration the present situation and the historical trajectory and background.

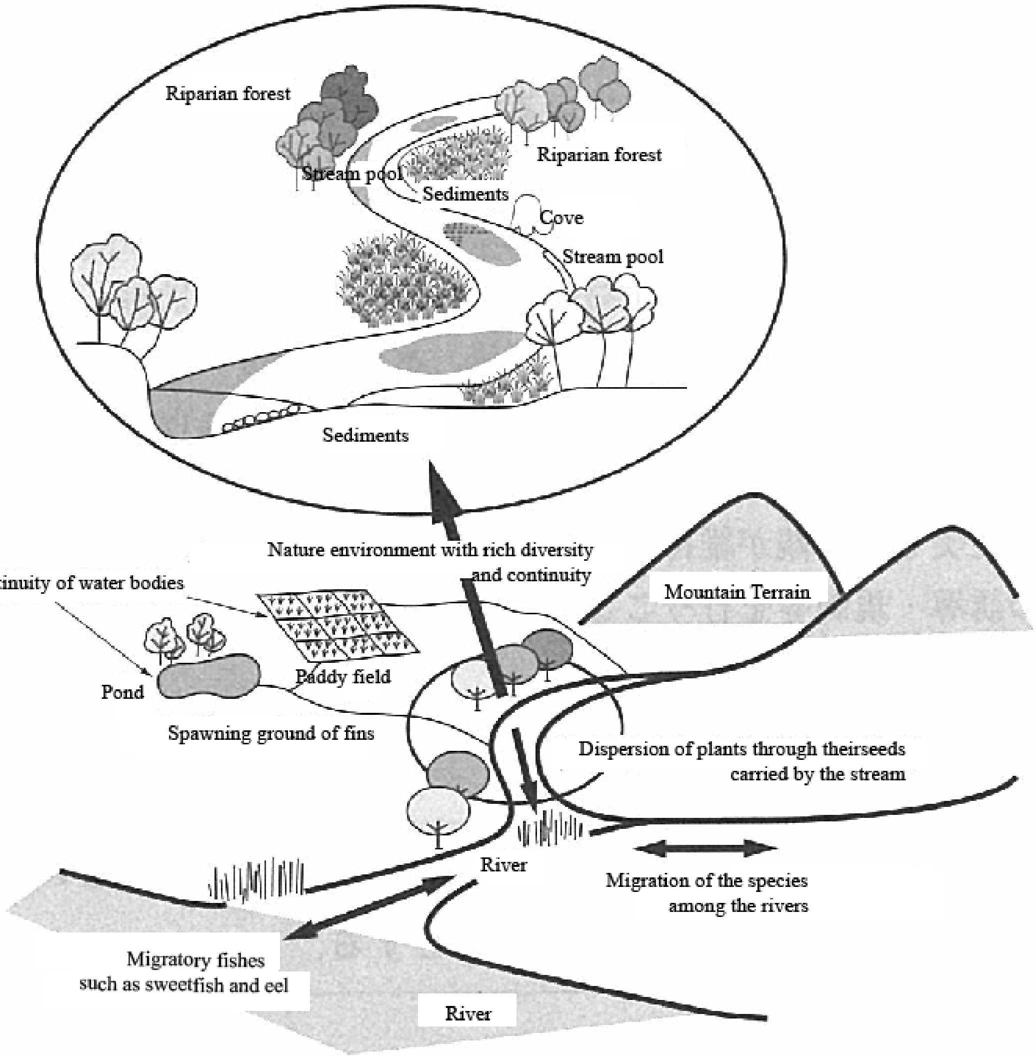


Fig.2-4 Stochastic illustration of the diversity and continuity of inhabitation and growth of the animals and plants

In focusing on these points of view, it is important to maintain, improve, and manage rivers so that the communities and habitats suitable for the river can be conserved, restored, and maintained in the future.

4.3 Maintaining and enhancing landscape quality

In the maintenance and management of rivers, efforts should be made to maintain and enhance landscapes formed around river water, taking into consideration the natural attributes of the river landscape and the historical and cultural background of the region.

Explanation

A riverfront landscape basically consists of a dynamic microtopography formed by the interaction between water flow, sediment movement, and the plants and animals (especially plants) living there. The present appearance of the landscape is the result of interactions between these natural processes and human interventions. The riparian landscape also reflects the living and growing environment for animals and plants. Therefore, changes in riparian landscapes occur in tandem with changes in the living and growing environment for animals and plants. The fundamental components of the natural riverside landscape are the microtopography, vegetation, and water flow, and these need to be emphasized in the maintenance and building of a good landscape.

From ancient times people have interacted with rivers in various ways such as flood prevention, waterborne traffic, utilization of river water for daily life and productive activities, expression of religious faith, etc., and the present river landscape has been formed through these historical and cultural backgrounds. For example, some cities that have developed as pivotal points of waterborne traffic still have boatslips, old clay structures, etc. along the riverside, and there are cases where these are valuable heritage items that represent the uniqueness of the region. Where the river is used in people's daily lives, there may be stairways that lead to washing places or the river itself. Structures for controlling the river flow and water level also constitute elements of the landscape. Revetments, embankments, flood damage-protection forests, etc. are also important elements of the landscape. The elements behind these landscapes, which have been formed through the interactions of human activity and the natural events associated with rivers, need to be well understood in terms of the historical trajectory and the regional uniqueness.

With its horizontal surface, water provides visual relief to people. It harmonizes with the treescape and helps to form unique, integrated scenery. In an urban city forested with buildings, a wide horizontal landscape provides a pleasant open space. A rippling water surface reflecting light presents various elements of expression and beauty, depending on how the water is illuminated and on the different angles of the waves—an effect only possible with water. Thus, efforts should be made to maintain and build water-based river landscapes by identifying water itself as an important element of these landscapes.

The values of river landscapes include their value as natural landscapes created through the interactions among the microtopography, water, and the creatures and plants of the river; their value as a human and social landscape fostered through the long relationship between people and the river; and their value as water-based landscapes. Although all of these values are important in the maintenance and building of a good landscape, it is important to judge, from the properties of individual rivers, which of these should be more important in the conservation and improvement of riverside landscapes.

To maintain and build a beautiful landscape centered around water as the key element, harmony with the surrounding landscape is important. It is also necessary to induce and control the landscape through coordination with relevant bodies, etc.

4.4 Maintenance and creation of places for activities that bring humans into close contact with rivers

> In the maintenance, improvement, and management of a river, efforts should be made to conserve the riverine environment and maintain and improve riparian places so that people can gain close contact with the river and coexist with nature.

Explanation

Activities that bring humans into contact with nature are not possible in all parts of a region. Therefore, it is important to plan activities that take advantage of the scenery and freshness of riverside areas, as well as the characteristics of the river or the region, such as historical and cultural resources, festivals and other special events. It is also important that people deepen their understanding of the river environment itself, as well as of the various natural and social factors peripheral to the river that affect them, and that the human interactions with the river will themselves not have any adverse impacts on the river environment.

In maintaining and creating places for human interactions with a river, it is important not only to build, improve, and maintain facilities and places but also to conserve the entire riverine environment itself, which includes the natural environment and landscapes as a background for these activities. It is also important to install, improve, and maintain facilities and places that integrate educational and welfare functions. In addition, although the use of a river is, as a rule, based on individual responsibility, it is important to have sufficient provision of safety-related information, education of river users, cooperation between relevant agencies and bodies in the river basin, and preparation for emergencies.

In the improvement and maintenance of facilities or places, efforts are to be made to ensure that the environment will be maintained in the future, taking into consideration the river shape and natural processes of the river (e.g. erosion and accumulation of sediment, movement of sandbanks).

4.5 Preservation of water quality

In river improvement and management, efforts should be made to preserve the quality of river water so that the river is properly utilized, the normal function of the river water is maintained, and the river environment is conserved.

Explanation

The water quality appropriate to maintain the normal function of river water and conserve the river environment is that which does not impair the various river-associated functions, including water utilization (e.g. water for domestic supply, agricultural water, industrial water, fishery water); conservation of habitat; securing of places for human interactions with the river; landscape management; conservation of peripheral living environments; tourism; protection of river management facilities; and maintenance of groundwater quality.

The term “water quality” includes the concept of riverbed condition.

In preserving water quality, it is important to grasp the relationship between the river basin and the water area, and it is also necessary to reflect the natural and social environments of the basin and their historical trajectories. This includes organisms that use to live and grow there in the past, as well as the relationship between changes in human interactions with the river and water quality. It is also important to address future changes in the condition of the river basin and changes in the residents’ attitudes in relation to sustainable production activities in the basin and requests made by riverside residents in regard to the river.

In addition, it is also necessary to examine possible countermeasures against unexpected water quality hazards and cases of abnormal water quality.

Chapter 3 Erosion and Sediment management Planning (Countermeasures for Sediment Disasters, etc.)

Section 1 General Information

Erosion and sediment management planning (countermeasures for sediment disasters, etc.) is the process of preparing master plans aimed at preventing or mitigating sediment-related disasters. Such plans include: landslide prevention plans; steep slope failure prevention plans; avalanche control and impact mitigation plans; and comprehensive sediment disaster prevention and impact mitigation plans aimed at combinations of debris flows, landslides, and steep slope failures.

Explanation

The term "river basins" also includes volcanic areas and areas at the base of volcanoes, steep slopes, etc.

"Sediment yield" means the production of unstable sediment through phenomena such as failure and erosion of a mountainside or slope as a result of heavy rainfall, snowmelt, earthquake, etc.. Mechanisms of sediment movement include debris flow, landslides, river bed or bank erosion, etc. The aim of prevention and mitigation of sediment disasters caused by sediment yield and discharge is to protect the lives of the general public, property, and the living and natural environments from direct disasters caused by the failure or erosion of a mountainside or slope, direct impact by debris flow, etc. They also aim to provide protection from indirect disasters caused by the burial of flood control reservoirs with sediment, flooding induced by riverbed accretion etc.

The following is a list of issues to be taken into consideration in erosion and sediment management planning.

- Social environment, including land use in the river basin, etc.
- History of past disasters and projects
- The level of safety against sediment disasters to be secured
- Comprehensive sediment management of the entire sedimentary system
- Conservation and restoration of a good natural environment
- Maintenance and building of a good landscape
- Utilization of river basins, etc.

Section 2 Erosion and Sediment management Master Plan

2.1 Overview

Erosion and sediment management master plans should be designed in such a way that hazardous sediment can be rationally and effectively managed within the design area to prevent and mitigate sediment yield in the subject river basin and sediment disasters caused by sediment discharge. Erosion and sediment management master plans include river system erosion and sediment management plans, debris flow control plans, large woody debris prevention plans, volcanic sediment and erosion control plans, and disaster prevention plans for abnormal sediment such as from landslide dams. These plans are to be developed and implemented in accordance with the disaster phenomena and the reasons for taking countermeasures.

Explanation

"Hazardous sediment" means yielded or discharged sediment likely to cause a sediment disaster.

Depending on the disaster phenomena and the purpose of the countermeasure, erosion and sediment management master plans can be divided into five categories:

1) river system erosion and sediment management plans, which aim to prevent or mitigate sediment disasters by controlling the movement of hazardous sediment into the river system from mountainsides and slopes, whereby sediment is yielded to torrents, the river, and eventually the seacoast;
2) debris flow control plans, which aim to prevent or mitigate disasters caused by debris flows;
3) large woody debris prevention plans to prevent or mitigate disasters caused by floating logs discharged with sediment;
4) volcanic sediment and erosion control plans, which aim to prevent or mitigate disasters caused by rainfall, volcanic activity, etc. in volcanic sediment and erosion control areas; and
5) abnormal sediment disaster prevention plans, which aim to prevent or mitigate disasters caused by abnormal sediment movement induced by landslides, dam collapse, etc.

Multiple plans from these five categories can be prepared for the same region simultaneously, depending on the disaster phenomena and the purpose of the countermeasure. In such cases, the plans should be developed separately for different disaster phenomena, and it is necessary to adjust each plan to maintain consistency between plans.

2.2 Basic items associated with river system erosion and sediment management

2.2.1 Overview

A river system erosion and sediment management plan should be established for the purpose of securing the flood control and water utilization functions of the river. It should also aim to conserve the environment through the prevention and mitigation of sediment disasters by controlling the movement of hazardous sediment into the river system from the mountainside, whereby sediment is originally yielded to torrents and eventually to the river. As part of the river system erosion and sediment management plan, a sediment management plan for rationally and effectively managing hazardous sediment should be designed based on the design sediment discharge, etc. In river systems where problems related to sediment movement are evident, the plan should be established by taking into consideration the promotion of comprehensive sediment management.

Explanation

In designing a river system erosion and sediment management plan, there are three elements that need to be considered: 1) sediment discharge, 2) sediment quality (grain size), and 3) the time scale of sediment movement.

A conceptual diagram of sediment movement in a river system erosion and sediment management plan formed around these elements is shown in Figure 3–1. Since a river system erosion and sediment management plan must to be based on an understanding of the processes occurring within the system, and thus accumulated data, it is necessary to conduct sediment monitoring.

The subject time scales for sediment movement should be categorized into short-term, medium-term, and long-term, and sediment movement phenomena should be determined for each of these periods.

As a guide, the short-term period should be determined from the duration of a series of rainfall events that cause the design-scale phenomenon.

The medium-term period should be set to somewhere between a few years and several decades, which is considered to be the period of time necessary for the sediment yielded by short-term rainfall events to move and start having effects on the surrounding environment.

The long-term period should be set to between a few and several decades or longer that covers the short-term and the medium-term periods.

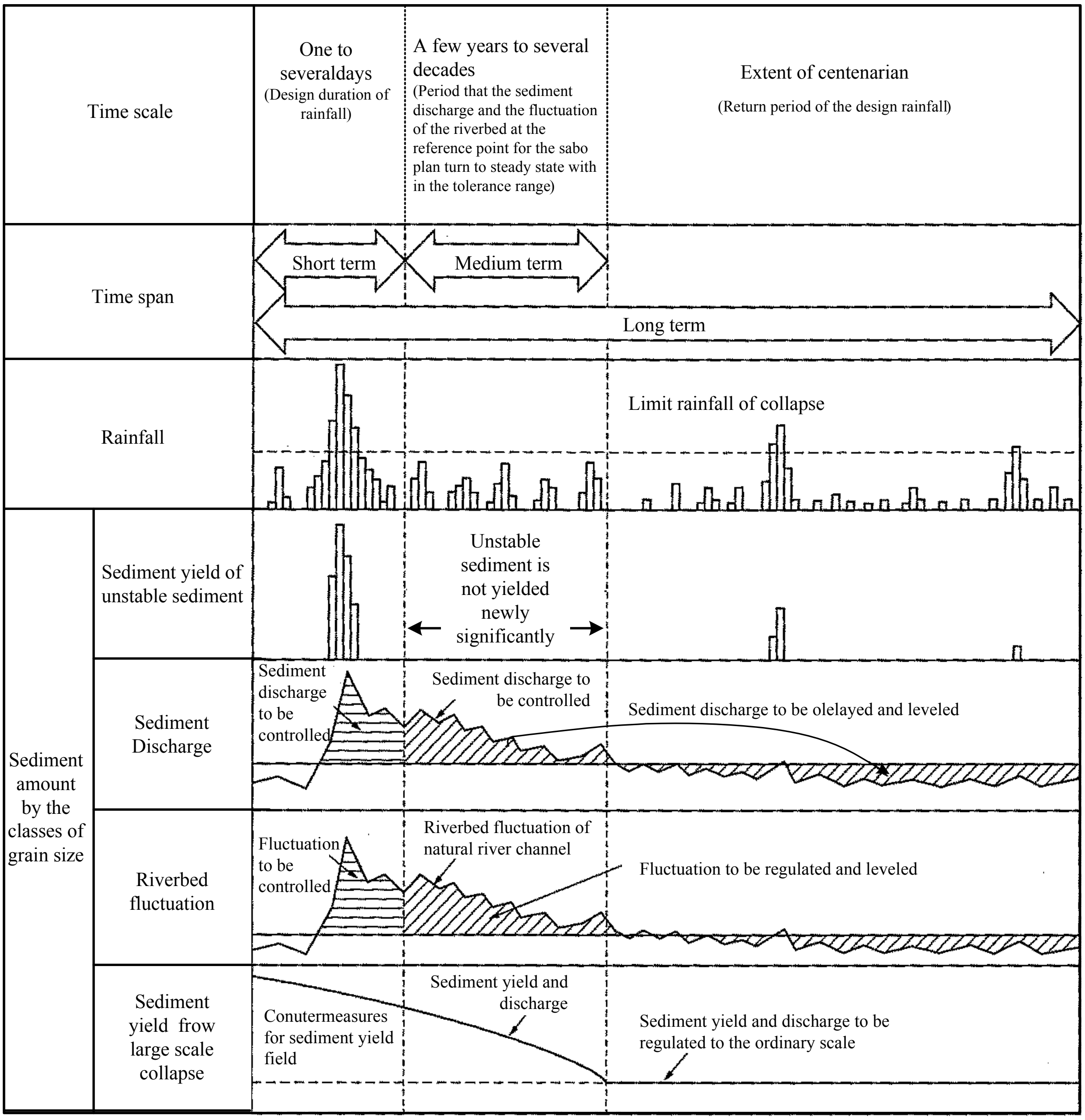


Fig.3-1 conceptual diagram of Sabo plan for the whole river system

2.2.2 Design scale

The design scale of a river system erosion and sediment management plan should generally be determined from an evaluation of the probability of the subject rainfall exceeding the annual precipitation, while also taking into consideration various factors such as past disasters in each river system, the importance and beneficial and adverse effects of the planning area, etc.

Explanation

The subject rainfall is determined by three elements: rainfall precipitation, temporal distribution, and spatial distribution. Refer to Section 2.6 of Chapter 2 for how to determine the subject rainfall.

The design scale should be appropriately determined from the subject rainfall, taking into consideration the occurrences of sediment movement phenomena in past disasters. The design scale of sediment discharge by bed load transport should be determined in accordance with Section 2.5 of Chapter 2.

2.2.3 Design control points in the erosion and sediment management master plan

Design control points in are points at which targets are set for sediment volume. Design control points are to be set in the lowest reach of the target design area, at locations associated with river planning, in upper reaches that are targets for conservation, and in the lowest reach of areas where sediment is likely to be yielded, among others. Auxiliary reference points are to be set in case it is necessary to determine sediment movement at a point where the sediment movement pattern changes, for example, in the upper reach of a tributary that is the target for conservation or at a confluence of the main stream and a tributary.

Explanation

Design control points are to be positioned where the regional characteristics are well reflected, in order to clarify the subject of the river system erosion and sediment management plan and ensure consistency with the sediment management plan within the entire planning area of the river system erosion and sediment management plan.
Auxiliary reference points should be set at more than one location if necessary.

2.2.4 Design sediment volume

The design sediment yield, the design sediment discharge, and the design tolerable sediment discharge should be determined as the design sediment volumes necessary to develop a sediment management plan as part of the river system erosion and sediment management plan.

Explanation

The design sediment yield includes newly eroded sediment from mountainside or riverside collapse, sediment from the expected expansion of old collapses, and residual sediment from old collapses that is likely to be discharged at the time of collapse occurrence or is accumulated on the river bed and becomes the subject of secondary erosion. The design sediment yield is determined from data from surveys of the present status, surveys of past disasters, surveys in similar areas, etc.
The design sediment discharge is the part of the design sediment yield that is transported by the tractive force of a debris flow or runoff from design scale rainfall and which reaches the design control points. It is to be determined in consideration of past sediment discharges, the topography of the basin, the adjustment capacity of the river channel, etc.
When computing the tractive force, it is desirable to use the flow rate of the runoff calculated in consideration of the characteristics of mountain streams.
The design tolerable sediment discharge is a sediment volume that presents no hazard at the design control point, the downstream area, or the sea coast. It should be transported as necessary sediment and is determined in consideration of the tractive force of the water flow, the grain size of the discharged sediment, the present status

of the river channel, river channel planning, etc. In river systems where problems related to sediment movement are evident, the design tolerable sediment discharge should be determined by considering overall sediment management.

It is desirable that the design sediment yield, the design sediment discharge, and the design tolerable sediment discharge are represented by the sediment quantity and quality (grain size), depending on the temporal variability of sediment movement. Efforts should be made to determine the design sediment yield, taking into consideration not only the sediment quantity and quality (grain size) but also the sediment yield pattern, place of yield, and occurrence timing.

2.2.5 Sediment management plan

The sediment management plan aims to rationally and effectively manage the sediment volume, which is the difference between the design tolerable sediment and the design sediment discharge; this is subject to sediment management at the design control points. The sediment management plan consists of a sediment production control plan and a sediment transportation control plan, which are interrelated.

Explanation

In developing a sediment management plan, the design sediment yield control volume, which is necessary for the sediment yield control plan, together with the design sediment discharge control volume and the design sediment discharge adjustment volume, which are necessary for the sediment transportation control plan, needs to be determined for the relevant design control points (auxiliary reference points). They should satisfy the following formula:

$E = (Q + A – B) (1 – \alpha) – C – D$

E: Design tolerance sediment discharge volume

Q: Design sediment discharge volume at the auxiliary reference point immediately upstream of the relevant design control point (or auxiliary reference point)

A: Design sediment yield volume

B: Design sediment yield control volume

α: Ratio of the sediment volume, which is adjusted in the river channel and does not flow downstream below the design control point (or auxiliary reference point), against $(Q + A – B)$

C: Design sediment discharge control volume

D: Design sediment discharge adjustment volume

α is determined in consideration of the conditions of the river basin. Refer to Section 7 of this chapter for considerations regarding the natural environment and landscapes.

2.2.6 Sediment generation control plan

A sediment generation control plan aims to rehabilitate sediment producing areas, prevent the occurrence of new sediment sources, and suppress hazardous sediment generation by controlling hillside failure, landslides, riverbed, and riverbank erosion.
In designing the plan, the design generated sediment needs to be rationally partitioned between hillside works, erosion control dikes, etc., taking into consideration the conditions in the sediment production area, the sediment production pattern, the sediment discharge pattern, the features requiring protection, etc.

Explanation

The targets of a sediment generation control plan are mountainous hillslopes, the primary source of sediment, and river channels, secondary sources of sediment.
The design amount of sediment to be managed by erosion and sediment management facilities is determined according to the capacity of existing erosion and sediment management facilities, and the topography, geology, vegetation, stability of the ground, and other relevant factors.

2.2.7 Sediment transportation control plan

Sediment transportation control plans are aimed at controlling hazardous sediment discharge with facilities that have sediment capture and adjustment functions, etc., and to allow non-hazardous sediment needed in the lower reaches to travel safely downstream.
In designing the plan, the design sediment discharge volume and design sediment discharge adjustment volume need to be rationally distributed to erosion control dikes, etc., taking into consideration the sediment yielding pattern, sediment volume and grain size, subjects for protection, geography, bed slope, present status of the river channel, etc.

Explanation

Sediment transportation control plans are concerned only with the river channel.
The design sediment discharge control volume should include that portion of the mobile sediment that could be stored in fixed amounts by facilities such as erosion control dikes. When debris-exclusion works are planned, the mobile sediment produced from such works can be included.
Generally, it is necessary to set the design amount of sediment discharge to be controlled to the volume between the stable slope of the sediment stored in fixed amounts in facilities such as erosion control dikes and the accumulating gradient of sediment that is anticipated to be produced by a flood. Since the sedimentation area of an erosion control dike is often designed to provide a river course adjustment function, the design sediment discharge adjustment volume from an erosion control dike needs to be determined by newly increased volume.
If the sediment capture and adjustment functions are enhanced by the installation of a silt dam, etc., then the effective volume needs to be evaluated appropriately.

2.3 Basic items associated with debris flow control

2.3.1 Overview

The purpose of a debris flow control plan is to protect people's lives, property, and public facilities from debris flows.

Explanation

Debris flows are a natural phenomenon involving the fluidized flow of earth, rocks, vegetation, etc. produced from hillside failure, usually along the sides of mountain streams, with the flow tending to be concentrated within the stream course where additional material may be recruited to the flowing mass from the stream bed or sides.

Disasters caused by debris flows are divided into two categories: 1) disasters caused by a direct hit from a debris flow; and 2) disasters caused by flooding following the debris flow, etc.

Disasters associated with direct hits from debris flows are caused by boulders, which travel at the tip of the flow, directly colliding with man-made structures, including houses.

Disasters caused by flooding from the flows succeeding debris flows occur from the accumulation of floodwaters behind the tip of the debris flow.

An example of a typical discharge pattern of a large-scale debris flow is shown in Fig. 3–2.

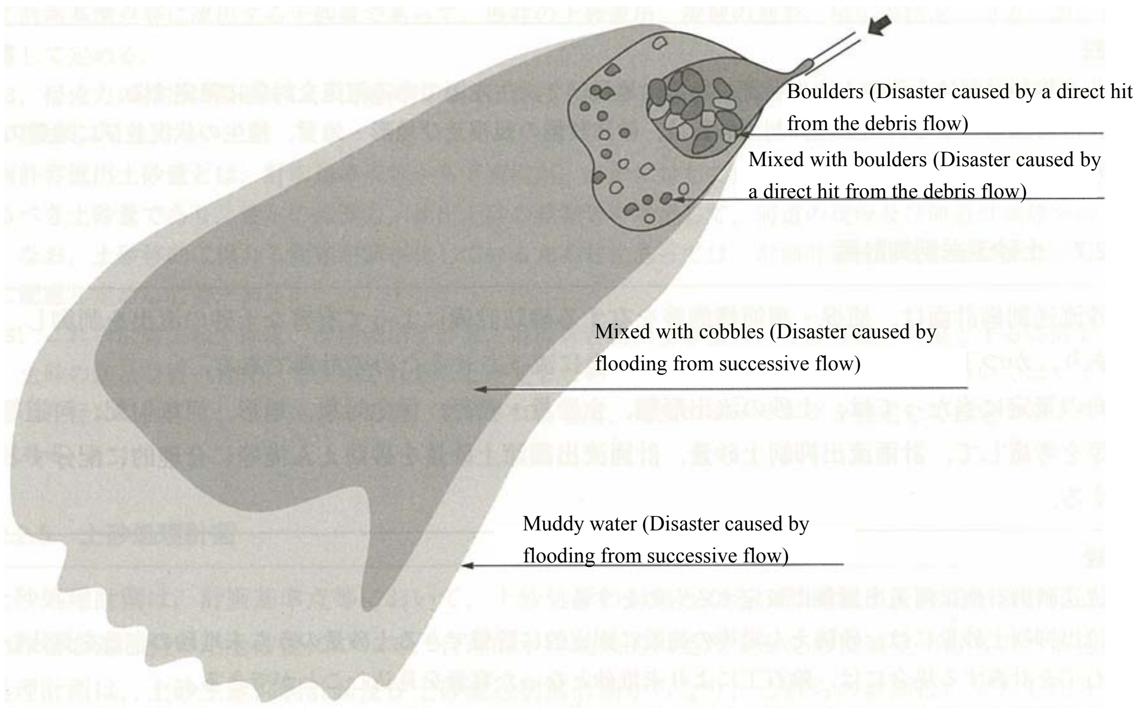


Fig. 3–2 Conceptual diagram of debris flow flooding

2.3.2 Design scale

The design scale of a debris flow control plan should be determined by taking into account various factors, such as the characteristics of the basin, the benefits and potential adverse impacts of the project, etc. It is generally determined by evaluating the probable sediment discharge volume from debris flows and the return period of the subject precipitation.

Explanation

The design scale should be determined in consideration of the characteristics of the basin, previous sediment movement phenomena during past disasters, etc. In evaluations that use the probability of the subject rainfall exceeding the annual precipitation, it is necessary to determine the scale of sediment movement that could be anticipated from a debris flow caused by that rainfall.

In mountain streams where debris flows occur frequently, the design scale may be determined from data on previous debris flows.

Since the behavior of debris flows caused by large-scale failure and landslides are not necessarily correlated with rainfall, it is necessary to set the design scale with reference to actual values associated with past debris flows in similar geography and geology in neighboring areas and other data.

2.3.3 Design control point, etc.

The design control point is the point at which the sediment volume for the debris flow control plan is to be determined. Generally the design control points should be established upstream, above the subjects to be protected. When it is necessary to grasp the state of sediment movement at points where the sediment movement pattern changes, auxiliary reference points should be established.

Explanation

Generally, when a facility is installed at the outlet of a valley upstream that is the subject for protection, or at the start point of debris flow accumulation, or downstream of the start point of debris flow accumulation, the design control point should be set downstream of the facility.

2.3.4 Basic items associated with countermeasures

A debris flow control plan aims to prevent or mitigate disasters caused by debris flows. It should consist of comprehensive measures properly combining structural measures for suppressing debris flow occurrence and controlling discharge (such as construction and improvement of erosion and sediment management facilities, etc.) with non-structural measures (such as establishment of a warning and evacuation system, land use control, etc.).

Explanation

Structural measures such as construction and improvement of erosion and sediment management facilities are aimed at preventing or mitigating disasters caused by debris flows. They should be designed such that they can

rationally and effectively prevent debris flow occurrence and control discharge.
Debris flows can cause serious damage, including loss of life. Therefore, in parallel with structural measures, efforts should be made to predict debris flow occurrences as an example non-structural measures. It is necessary to plan comprehensive measures, including non-structural measures for minimizing the damage caused by debris flows, by establishing warning and evacuation systems and information systems, controlling land use, etc.
In the course of developing a debris flow control measure, the design sediment volume should be determined in accordance with Section 2.2.4 of this chapter, and a sediment management plan should be designed in accordance with Section 2.2.5 of this chapter. If marked changes take place in the basin owing to natural factors such as a new slope failure, debris flow occurrence, destabilization of slopes as a result of earthquake, etc., or owing to anthropogenic factors such as land development, then the design sediment volume, etc. need to be reviewed and the debris flow control plan needs to be revised, as required.

2.4 Basic items associated with prevention of large woody debris

2.4.1 Overview

Large woody debris prevention plans for river basins where floating logs and large tributaries are a feature aim to protect the lives and property of the general public, as well as public facilities, etc. from disaster associated with woody debris discharged with sediment.

Explanation

Generally, when a failure occurs in steep river basins in forested mountains, logs coupled with sediment runoff may clog narrow parts of the river, bridge openings, box culverts, etc. as they travel downstream, resulting in flooding of sediment, etc. and runoff from bridges, etc. and posing a serious hazard to lives, housing, and public facilities such as roads.
A large woody debris prevention plan should be developed to control damage from the flow of large woody material due to slope failure, debris flows, and riverbed and side erosion, as well as from re-mobilization of past deposits of fallen trees and hewn logs.

2.4.2 Design scale

The design scale of a large woody debris prevention plan should be determined in consideration of various factors such as the characteristics of the basin, the volume of woody material discharged to the design control points, etc.

Explanation

The volumes of woody material in the plan should be represented as an actual volume of wood and calculated on the assumption that there are no facilities for preventing or reducing the occurrence and runoff of sediment and large woody debris in the basin.
Where it is predicted that the species, age, and timber volume of trees from the source area will not change, the volumes of timber runoff should be calculated from the areas of new hillside failure. This is determined from site

investigations and in the erosion and sediment management master plan.

The volumes of large woody debris (trees, logs, tributaries) that are deposited on the riverbed should be determined from their lengths and diameters through site investigations. Artificially produced floating logs, such as runoff of hewn logs and converted timbers, should be excluded from the plan.

2.4.3 Design control point, etc.

Generally, the design control points, etc. should be established upstream of the area where the subjects for protection are located. They should be identical to the design control points determined in the river system erosion and sediment plans, debris flow control plans, etc.

Explanation

Since large woody debris prevention plan are established in conjunction with river system erosion and sediment management plans, debris flow prevention plans, etc., and not by alone, the design control points must be identical to those used for the other kind of control plans.

2.4.4 Basic items associated with countermeasures

From the design sediment volumes determined in the river system erosion and sediment plans, debris flow prevention plans, etc., a large woody debris prevention plan should be established in such a way that it is consistent with the sediment management plan, erosion and sediment management facilities are properly located, and sediment is rationally and effectively controlled.

Explanation

Large woody debris prevention generally involves measures for preventing the generation of floating logs and large tributaries and measures for capturing such material in the river channel to prevent them being transported downstream. A large woody debris prevention plan must be consistent with the facilities in the river system erosion and sediment management plans, debris flow prevention plans, etc., taking into consideration each sediment occurrence and the behavior of floating logs, depending on the sediment runoff pattern.

If the situation in the basin, such as the forest status, drastically changes, the volumes of floating logs in the plan should be reviewed and the large woody debris prevention plan revised.

2.5 Basic items associated with volcanic sediment and erosion control

2.5.1 Overview

A volcanic sediment and erosion control plan aims to protect lives and property, public facilities, etc. from sediment disasters caused by rainfall events and volcanic activities in a volcanic sediment and erosion control area.

Explanation

A volcanic sediment and erosion control area means an area subject to damaging sediment disasters as a result of volcanic phenomena or movement of volcanic ejecta.

Disasters associated with volcanic eruptions can be highly destructive and extensive and their social impacts can be devastating and last for a long period of time after the eruption. Therefore, a volcanic erosion and sediment management plan needs to be consistent with regional plans, and, in parallel with the plan, construction and improvement of erosion and sediment management facilities and establishment of warning and evacuation systems need to be implemented in order to promote city-planning centering around safety and disaster prevention.

2.5.2 Subject phenomena, etc.

The phenomena subject to a volcanic erosion and sediment management plan include debris flows and volcanic mudflows caused by rainfall and volcanic events including lava flows, etc in area of the volcanic erosion and sediment management area.

The design scale of the target sediment movement phenomena should be determined in consideration of various factors, such as the natural and social characteristics of the area to be controlled, past volcanic activities and disasters, beneficial and adverse effects of the project, etc.

The design control points, etc. should be determined in accordance with Section 2.2.3 of this chapter.

Explanation

The target sediment movement phenomena in a volcanic erosion and sediment management plan should be basically debris flows and volcanic mudflows. Lava flows, etc. are included as necessary.

Other phenomena, such as pyroclastic flows, which are obvious when they occur and whose area of influence is predictable, need to be included in the plan if there is a likelihood of their occurrence. In such cases, ash falls, cinders, etc. should be evaluated as factors that affect the sediment-yielding region. Since sediment movement phenomena caused by rainfall events, etc. in volcanic erosion and sediment management areas are characterized by extremely different sediment-yield and runoff conditions (such as extraordinary erosion) compared to normal mountainous river basins, these should be taken into consideration in planning.

2.5.3 Basic items associated with countermeasures

A volcanic erosion and sediment management plan should be established as a comprehensive measure that appropriately combines structural measures (such as improvement of erosion and sediment management facilities) with non-structural measures (such as establishment of warning and evacuation systems, land use control, etc.). In this case, it should be established in accordance with Section 2.3.4 of this chapter.

A plan that targets lava flows, etc. at the time of eruptions should be established if this is deemed necessary from the consideration of past volcanic activities.

Explanation

In designing a volcanic erosion and sediment management plan, the design sediment volume, etc. should be determined for target phenomena in the volcanic erosion and sediment management area in accordance with Section 2.2.4 of this chapter. The design sediment volume, etc. should be properly determined from past disaster and eruption records, etc., taking into consideration the characteristics of sediment movement phenomena in the subject volcanic erosion and sediment management area.

Debris flows caused by rainfall events, etc. should be determined for each sediment yielding area and basin in compliance with the basic items associated with river system erosion and sediment management in Section 2.2, the basic items associated with debris flow control in Section 2.3, and the basic items associated with large woody debris prevention in Section 2.4 of this chapter.

A volcanic erosion and sediment management plan targeted at eruptions should be established in consideration of various structural measures (such as improvement of erosion and sediment management facilities) and non-structural measures (such as establishment of warning and evacuation systems). It is desirable to design non-structural measures that assume phenomena exceeding the design target phenomena. For appropriate provision of information by municipal governments about warning and evacuation, non-structural measures should include preparation of volcanic hazard maps, establishment of warning and evacuation criteria, and monitoring of volcanic activities and sediment movement.

After the preparation of volcanic hazard maps, efforts should be made to publicize them so that local public bodies can guide land use based on them. It is necessary to keep in mind the fact that land use control can also be one of the non-structural measures used to facilitate prompt action at the time of disasters, such as those caused by eruptions.

Equipment for monitoring sediment movement, etc. should be selected in consideration of the characteristics of the subject volcanic erosion and sediment management area, and it is desirable to establish a system that allows appropriate information provision through the combined use of multiple equipment, etc.

In order to quickly and properly deal with disasters such as a sudden volcanic eruption, structural emergency plans such as construction of guide banks and flow channels, as well as non-structural measures such as monitoring of volcanic activity, should be planned..

In planning facility locations, it is necessary to thoroughly consider the local conditions, such as the natural environment (refer to Section 7 of this chapter).

When a remarkable change occurs, such as the status of volcanic activity or a new occurrence of sediment movement, the target phenomena in the plan should be reviewed and the volcanic erosion and sediment management plan revised if required.

2.6 Prevention of abnormal sediment disasters

2.6.1 Overview

Plans for preventing abnormal sediment disasters should be aimed at protecting lives and property and public facilities from sediment disasters such as the formation and collapse of landslide dams or from other types of rare events.

Explanation

Although disasters caused by the collapse of landslide dams, etc. do not occur frequently, their occurrence will generate large amounts of sediment resulting in tremendous damage. Therefore, a plan for preventing abnormal sediment disasters such as those associated with landslide dams should be designed when a landslide dam forms, depending on the phenomena that occur, etc. When a sediment disaster can be predicted in advance, it is necessary to take preventative measures.

2.6.2 Target phenomena, etc.

The target phenomena in a plan for preventing abnormal sediment disasters include: the potential submersion of items requiring protection upstream of a landslide dam formed in a river channel due to heavy rainfall or an earthquake; large-scale debris flows caused by the collapse of a landslide dam; debris flows caused by large-scale failure due to earthquakes.

The target scale of sediment movement phenomena in the plan should be determined in consideration of various factors, such as the phenomena of sediment runoff downstream caused by the collapse of landslide dams.

The design control points, etc. should be determined in accordance with Section 2.2.3 of this chapter.

Explanation

The design control points, etc. should be determined in accordance with Sections 2.2.3 and 2.3.3 of this chapter, depending on the target phenomena.

2.6.3 Basic items associated with countermeasures

A plan for preventing abnormal sediment disasters should aim to prevent or mitigate the damage likely to be caused. It should be a comprehensive plan combining structural measures (such as the construction and improvement of erosion and sediment management facilities, including drainage channels for draining the flooding caused by a landslide dam) with non-structural measures (such as determination of the hazard expansion area, monitoring of landslide dams, etc.).

Explanation

A plan for preventing abnormal sediment disasters such as those caused by landslide dams will combine structural measures (such as emergency measures for preventing or mitigating abnormal sediment disasters) with non-structural measures (such as: assessments of slope stability and the risk of landslide dam collapse; preparation of hazard maps of areas at risk due to flooding in the event of landslide dam formation and collapse; monitoring of landslide dams).

Emergency measures should include measures both for the landslide dam site itself and for the area downstream of the landslide dam, depending on the constraints of construction and the stability of the landslide dam.

Emergency measures at the landslide dam site include excavation of sediment forming the dam body (channel installation), dam body sediment removal, and installation of cutoff walls made of steel sheet piles. Downstream measures include the exclusion of debris from the area of sedimentation of existing erosion and sediment management facilities, installation of new erosion and sediment management facilities, etc. as measures downstream.

Proactive measures include the installation of erosion control dikes, etc.

An erosion and sediment management facility installation plan needs to take the occurrence of disasters exceeding the design scale into consideration.

Risk assessment to support warning and evacuation systems implemented by municipal governments and include the examination of stability with respect to slope failure and landslides. Stability can be determined from the general risk assessment of long slope failure and landslides. In assessing the risk of landslide dam collapse, it is necessary to consider overflow from the dam as well as piping and slip failure of the downstream face of the dam due to infiltrated water.

The areas subject to hazard include upstream inundation areas due to the filling of the dam and downstream flooding areas caused by collapse of the dam. Upstream inundation area should be predicted from geological maps on the assumption that the highwater mark will be equal to the height of the landslide dam. In the case of a landslide dam collapse, the area of hazard should be predicted by comparing the maximum depth of flood occurring downstream of the landslide dam with the elevation at that location.

Section 3 Landslide Prevention Plan

3.1 Overview

The aim of a landslide prevention plan aims is to protect lives, property and public facilities from landslides.

Explanation

Disasters associated with landslides occur under conditions particular to this nation, such as its characteristic topography, geology, climate, and land uses. These disasters are roughly divided into two types: 1) direct disasters, where the subject requiring protection is located on a landslide slope or within reach of a moving soil mass generated by a landslide; and 2) indirect disasters, which affect areas upstream and downstream through the blocking of rivers by sediments or the secondary collapse of river-clogging sediments.

The aim of a landslide-prevention plan is to prevent or mitigate these direct and indirect landslide-related disasters, and it should be developed from preliminary landslide surveys and the analyses thereof. The various conditions of the landslide-prevention area, such as topography, geology, climate, land use, the status of the subjects requiring protection, and the urgency of protection all need to be taken into account.

Since landslides generally occur on a large scale and consist of two or more movement blocks, it can take many years are to complete construction works. On the other hand, because there are often many houses and public facilities on the landslide slope and within reach of the moving soil mass generated by the landslide, non-structural measures such as an appropriate warning and evacuation system are essential to cope with the threat of the landslide being activated. For this reason, a landslide-prevention plan needs to take into consideration not only structural measures such as construction and the improvement of landslide-prevention facilities but also non-structural measures to ensure the establishment of a warning and evacuation system.

The plan must be kept consistent with the surrounding environment, relevant laws and regulations and regional plans.

Once a landslide-prevention plan is established, it needs to be properly reflected in the landslide-prevention works master plan stipulated in Article 9 of the Landslide Prevention Act.

3.2 Basic items associated with landslide prevention

3.2.1 Target phenomena, etc.

The target phenomenon in a landslide-prevention plan is the sliding of specific portions of land as a result of groundwater flows, or the resulting movement of the land.
The target planning scale should be determined in consideration of various factors, such as the landslide phenomenon itself, the importance of the subjects requiring protection, the urgency of the project, and the beneficial and adverse effects of the project, etc.

Explanation

In a landslide-prevention plan, measures should be planned to deal with the movement phenomenon resulting from groundwater flows, etc., and the phenomena that follow this movement. Lands currently continuing to move, or those that show a landslide configuration and may move, should be targeted. Since landslide phenomena often show different movement patterns depending on natural conditions, such as topography and geology, in establishing the plan it is necessary first to fully understand the target landslide phenomenon and then to properly determine the target planning scale.

3.2.2 Basic countermeasure principles

A landslide-prevention plan needs to be a comprehensive measure combining structural measures with non-structural measures such as the establishment of a warning and evacuation system, as well as land-use control, etc.

Explanation

Structural measures for landslide prevention need to take into consideration the land uses in the landslide-prevention area and surrounding areas, etc. These measures should be designed so that the landslide-prevention facilities are arranged rationally and effectively to ensure the desired level of safety.
Non-structural measures mainly refer to the establishment of a warning and evacuation system and land-use control, among others. To contribute to appropriate warning and evacuation, monitoring equipment such as ground extensometers and ground tiltmeters need to be installed for speedy data collection, and efforts should be made to establish an appropriate communication system that connects with relevant organizations and bodies.
In the case of a landslide occurring around a dam reservoir, it is necessary to examine the effects of filling level fluctuation, etc.
In planning the construction or improvement of landslide-prevention facilities, it is necessary to take into full consideration the natural environment of the target area and surrounds, including the landscape and ecosystem, as well as the living environment, etc. For more details, refer to Section 7 of this chapter.

Section 4 Steep Slope Failure-prevention Plan

4.1 Overview

A steep slope failure-prevention plan should be established for the purpose of protecting lives and property from disasters caused by steep slope failures.

Explanation

The occurrence of steep slope failures is intricately connected with topographical, geological, vegetation, and rainfall characteristics, and it is extremely difficult to predict the location and timing of such occurrences. In addition, with the accompanying rapid large sediment movement, once a steep slope failure occurs it often leads to a life-threatening disaster.

Steep slope failure-prevention plans should include measures to construct and improve steep slope failure-prevention facilities and to regulate the occurrence of new risks by establishing a warning and evacuation system, constraining activity within a steep slope area in danger of failure, and limiting the construction of residential buildings. It should also ensure safety by encouraging landowners and those who may be affected by any disaster to take disaster-prevention measures and advising them on building relocation, etc.

A steep slope area in danger of failure means an area of land for which control of activity is required so that steep slope failure is not accelerated or triggered on the steep slopes or on neighboring land where a considerable number of residents or developments may be subjected to damage due to the failure.

4.2 Basic items associated with steep slope failure-prevention measures

4.2.1 Target phenomena, etc.

The target phenomena in a steep slope failure-prevention plan are the failures of steep slopes as a result of natural phenomena such as rainfall events and earthquakes.

The design planning scale should be determined in consideration of various factors, including the presumed phenomena of steep slope failure, the importance of the subjects requiring protection, the urgency of the project, and the beneficial and adverse effects of the project, etc.

4.2.2 Basic countermeasure principles

A steep slope failure-prevention plan needs to be a comprehensive countermeasure that combines structural measures such as construction and improvement of steep slope failure-prevention facilities with non-structural measures such as the establishment of a warning and evacuation system, land-use controls, etc.

Explanation

The construction of a steep slope failure-prevention facility should be planned within a steep slope area in danger of failure in consideration of the importance of the subjects to be protected and the beneficial and adverse effects of the facility.

A warning and evacuation system should be established to predict disaster occurrence in advance and support early evacuation of community members from the area that is anticipated to receive damage.

To support smooth warning and evacuation processes by municipal governments, it is vitally important to quickly and accurately grasp the climatic conditions, the predicted rainfall, the standard rainfall level at which warning and evacuation are required, and the presence of precursory phenomena. To quickly and accurately gather such information and to share disaster-related information among relevant organizations and bodies and community members, efforts are needed to establish an appropriate information and cooperation system.

In establishing a steep slope failure-prevention plan, it is also necessary to adequately coordinate the plan with other projects that are planned from other laws and regulations and institutions, and to maintain consistency regarding the positioning of the subject slope in regional plans, etc.

For considerations associated with the natural environment, refer to Section 7 of this chapter.

Section 5 Avalanche Prevention Plan

5.1 Overview

> An avalanche-prevention plan should be established for the purpose of protecting the lives of the general public from disasters associated with avalanches.

Explanation

An avalanche-prevention measure aims to protect people's lives from disasters caused by avalanches, and it should be appropriately implemented through the construction and improvement of avalanche-prevention facilities, the spread of information on places where avalanche hazards are likely to occur, and the establishment of a warning and evacuation system.

An avalanche-prevention measure should target mainly hillside slopes and their surrounding areas.

In cases where there are items to be considered regarding relevant laws, regulations, and institutions, as well as aspects of the surrounding environment other than those stipulated in this chapter, the plan also needs to take these into consideration.

5.2 Basic items associated with avalanche-prevention measures

5.2.1 Target phenomena, etc.

> The target phenomena in an avalanche-prevention plan are surface and total layer avalanches as well as snow cover movement (creep or glide) on slopes. The design planning scale should be determined in consideration of various factors such as predictable avalanche phenomena, the importance of the subjects requiring protection, the urgency of the project, and beneficial and adverse effects of the project, etc.

Explanation

An avalanche-prevention plan centers around areas in danger of avalanche. The design scale should be determined by selecting areas with a high avalanche hazard and determining the extent of the likely avalanche. This depends on the type and scale of predictable avalanches, as determined from the findings of topographic surveys, vegetation surveys, and other avalanche-associated surveys, while taking into consideration the characteristics of the area requiring protection.

The area in which a measure or measures are required in accordance with the design scale is the design target area.

An avalanche hazard area should cover an area with a slope of 18 degrees or more when the point at which the surface gradient becomes less than 15 degrees in the upper part of a hillslope with a surface slope of 15 degrees or more and a height of 10 meters or more is viewed.

5.2.2 Basic countermeasure principles

An avalanche-prevention plan should be a comprehensive measure that properly combines structural measures to constructing or improving avalanche-prevention facilities with non-structural measures such as the establishment of a warning and evacuation system.

Explanation

Avalanche-prevention facilities should be planned in consideration of the importance of the subjects for protection and the beneficial and adverse effects of avalanche-prevention facilities, etc.

The establishment of a warning and evacuation system aims to predict the occurrence of avalanche disasters and support early evacuation from areas that are predicted to receive damage. This should be done at the prefectural and municipal levels and for relevant organizations, bodies, and community members. To this end, the plan needs to take into consideration the provision to community members of various details such as the predicted avalanche occurrence area, the avalanche path, the sedimentary province, and the movement pattern of the avalanche. It should also encompass the establishment of an appropriate communication and cooperation system for information sharing among the relevant organizations and bodies and community members.

For considerations related to the natural environment, etc., refer to Section 7 of this chapter.

Section 6 Comprehensive Sediment Disaster-prevention Plan

6.1 Overview

The aim of a comprehensive sediment disaster-prevention plan is to prevent or mitigate complex sediment disasters caused by multiple disasters, such those caused by sediment yield and runoff in the basin, landslides, steep slope failures, etc., and it should be established combining structural and non-structural measures.

6.2 The elements of comprehensive sediment disaster-prevention

Comprehensive sediment disaster-prevention should be planned by determining the target phenomena, scale, and extent from the regional characteristics and land-use status. It should combine structural measures with non-structural measures such as the establishment of a warning and evacuation system and land-use controls, etc.

Explanation

To support the development of the plan, detailed surveys of the regional characteristics should be conducted, including the natural conditions (topography and geology), regional plans of the municipal government, and the status of land-use controls based on relevant laws and regulations, etc.

A comprehensive plan must be established after identifying the area at risk and special damage potential zone in accordance with the Act for the Promotion of Measures for Sediment-related Disaster Prevention in Damage Potential Zones, etc.. It should incorporate the establishment of a warning and evacuation system; the implementation of land-use controls; the regulation of building structures; and the relocation of residences.

In designing warning and evacuation systems, the plan should be designed to take into consideration the comprehensiveness and efficiency of observations of the phenomena that may cause sediment movements associated with debris flow, landslides, and steep slope failure; the establishment of an information-gathering and communication system that facilitates fast and accurate forecasting; and the establishment of an information system that allows interactive information exchange with community members, etc.

6.3 Urbanized foothills greenbelt development plan

6.3.1 Overview

An urbanized foothill greenbelt development plan should be planned as a comprehensive measure based on the urbanized foothill greenbelt master plan. It should aim to develop a region that is resistant to sediment disaster, maintaining consistency with regional plans, etc., and making use of the various functions and effects of trees. It should also properly combine structural measures such as the construction or improvement of erosion- and sediment-control facilities, landslide-prevention facilities, steep slope failure-prevention facilities, etc. with non-structural measures such as land-use controls.

Explanation

An urbanized foothill greenbelt is a slope greenbelt that consists of a series of forests on hillsides, in mountain stream areas, and on the foothill slopes neighboring urbanized areas for the purposes of sediment disaster prevention and mitigation. These greenbelts are also intended to help form good urban environments and pleasant scenery and landscape; they should conserve and foster ecosystem conservation in hilly urban fringes that may be susceptible to sediment disaster.

In light of their purpose, urbanized foothill greenbelt master plans are established by municipal governments as comprehensive plans that stipulate the basic functions and measures for future urbanized foothill greenbelt development in cooperation with relevant organizations and bodies and by coordinating land-use controls, etc. based on relevant laws and regulations. These master plans utilize greenbelts for provision of extensive disaster-prevention zones.

An urbanized foothill greenbelt development plan should be based on a master plan and include a comprehensive sediment disaster-prevention plan with specific measures for erosion and sediment management to be implemented by the responsible agencies.

In an urbanized foothill greenbelt development, it is important to implement the necessary measures such as the conversion of tree species to make full use of the various functions and effects of trees, in addition to the comprehensive development of erosion- and sediment-control facilities, landslide-prevention facilities, steep slope failure-prevention facilities.

The plan needs to be consistent with regional plans and with land-use control plans based on relevant laws and regulations.

6.3.2 Basic countermeasure principles

An urbanized foothill greenbelt development plan should be established in such a way that forest conservation and cultivation and forest structure improvement are implemented to maintain and improve the forest's function of controlling sediment yield and discharge due to surface erosion, etc. The plan should also be designed to create and conserve areal disaster-prevention space by the implementation of measures such as construction or improvement of erosion- and sediment-control facilities, etc. It is particularly important for urbanized foothill greenbelts to be coordinated with other projects and land-use controls based on relevant laws and regulations so as to prevent uncontrolled urbanization and ensure the security of the subject region.

In developing a plan, sufficient consideration needs to be given to the building of a good urban environment, the creation of scenery and landscapes, ecosystem conservation, and the provision of places for healthy recreation, etc.

Explanation

A comprehensive measure should be planned to form a series of areal woody corridors neighboring an urban district and to construct or improve erosion-control dykes and erosion- and sediment-control facilities through hillside works, landslide-prevention facilities, and steep slope failure-prevention facilities, etc. The aim is to prevent and mitigate disasters due to sediment discharge, such as debris flows, landslides, steep slope failures, etc., on hillsides, in mountain stream areas, and in foothills on the outskirts of cities within urbanized foothills. It is particularly desirable that the plan is designed not only in cooperation with other projects, such as park projects, through the designation of damage-potential zones, etc., but also in appropriate cooperation with land-use controls etc. based on laws and regulations such as the City Planning Law for the purpose of preventing uncontrolled urbanization.

Since it is expected that appropriate conservation and growth of forests and improvement of forest structure will bring about beneficial effects such as the formation of a good urban environment, the preservation of scenery and landscapes, the conservation of habitat for animals, and the provision of places for healthy recreation, the design of the plan needs to take into consideration the actual status of the region for which these effects are planned.

Section 7 Consideration of the Natural Environment

In establishing an erosion- and sediment-control master plan, landslide-prevention plan, steep slope failure-prevention plan, avalanche-prevention plan, or a comprehensive sediment disaster-prevention plan, sufficient consideration needs to be given to the natural environment and landscape in and around the design area.

Explanation

Mountainous slopes, mountain streams, river channels and areas adjoining such natural spaces are associated with distinct ecosystems and landscapes.

In establishing an erosion- and sediment-control master plan, landslide-prevention plan, etc. for a particular river basin, or other geographic unit, it is necessary to fully consider existing conditions, including habitat for animals and plants, the landscape, water quality, etc., as well as the location, shape, and structure of proposed facilities to secure the continuity of the living and growing environment for plants and animals and a good quality landscape.

For details of the promotion of comprehensive sediment management, including the securing of continuity of sediment movement in sediment transport systems, refer to Section 4 of Chapter 1.

Since one of the purposes of an erosion- and sediment-control master plan is to restore degraded natural environments to their original state, efforts need to be made to use native species when introducing vegetation to a degraded area. It is desirable to select species that are in harmony with the natural environment of the local and downstream areas. In the process of re-vegetation, goals need to be set, and it is desirable to perform maintenance as required.

Existing vegetated slopes in an urban district are important components of the urban landscape and are valuable spaces for conservation of plant and animal habitat. Therefore, measures to construct or improve erosion- and sediment-control facilities, landslide-prevention facilities, steep slope failure-prevention facilities, and avalanche-prevention facilities need to consider the surrounding living environment, etc., the conservation of existing trees, and the introduction of new vegetation by using native species.

Chapter 4 Seacoast Preservation Planning

Section 1 General Information

A seacoast preservation plan aims to preserve, restore, and improve the functions of a seacoast and thereby improve and preserve coastal protection and the coastal environment, ensure appropriate use of the public seacoast, and create a harmonized coastal space. This chapter describes basic items associated with coastal protection, improvement and conservation of the coastal environment, and seacoast utilization. These are basic items that need to be examined in the establishment of a seacoast preservation plan. A seacoast preservation plan must be a comprehensive plan based on all these items.

Explanation

Seacoasts are valuable assets for humankind, and they need to be properly evaluated as land, places for marine recreation, parks, places for agriculture and fisheries, scenic sites, ecological systems, historical and cultural spots, livelihood spaces, etc., and passed down to future generations. On the other hand, severe natural conditions and changes in social and economic environments have caused disasters due to storm surges, tsunamis, and coastal erosion.

Historically, there have been cases in which a coastal environments have been damaged and access to the seacoast prevented due to coastal protection works. There have also been cases in which gently sloping coastal dikes and revetments constructed to secure access to a beach have reduced the natural beach area, prevented use of the beach, eliminated the plant and animal habitat, and increased wave overtopping rates.

In public administration, the term "seacoast preservation" has been used mostly to mean coastal protection as in the term "coastal protection facility", but a seacoast preservation plan involves "preservation" as a comprehensive term, the definition of which includes preservation of the coastal environment and beach use (Fig. 4–1).

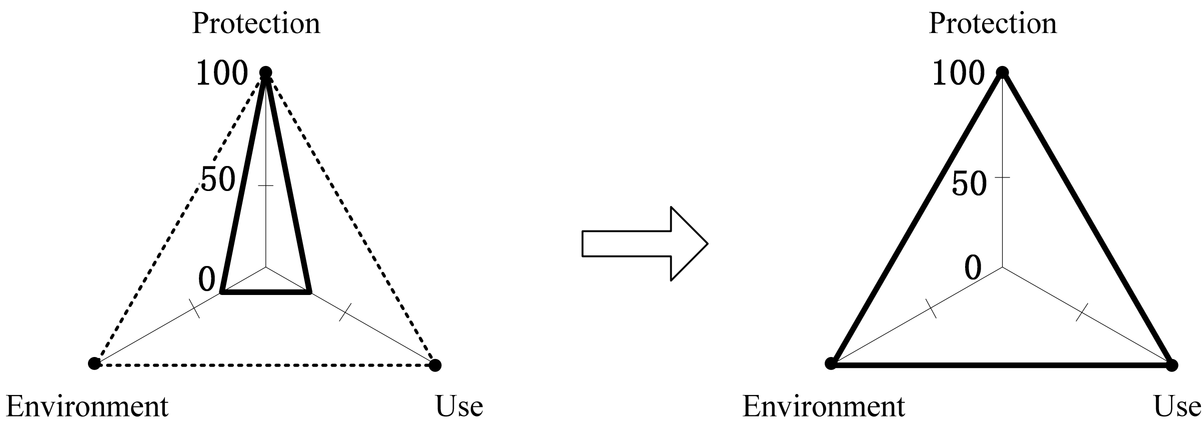


Fig.4-1 Direction of seacoast preservation

Figure 4–2 shows the organization and flow of plans. A plan consists of a seacoast preservation plan, which is a master plan, and a seacoast preservation facility arrangement plan, which defines the type, arrangement, and scale of facility, etc. A seacoast preservation plan is composed of basic items associated with seacoast preservation, improvement and conservation of the coastal environment, and seacoast use, all of which are the purposes of seacoast preservation. A seacoast preservation plan should not aim to provide the best outcome for the individual areas of coastal preservation, environmental conservation, or use of the seacoast, but must aim to comprehensively optimize these three features. To this end, there are cases in which plans may need to be reexamined.

In a seacoast preservation facility arrangement plan, the organization of seacoast preservation facilities, etc. that satisfy the basic items defined in a seacoast preservation plan, as well as the arrangement and scale needed to acquire the necessary performance, should be determined. Since erosion, storm surge, and tsunami facilities are planned as integral parts of the plan, there are cases that call for reexamination. Also, in the process of examining a facility arrangement plan, it is necessary to confirm that the coastal preservation, environmental conservation, and use goals determined in the seacoast preservation plan are satisfied. If these goals are not satisfied, then it is necessary to reexamine the seacoast preservation plan. The seacoast preservation plan and the seacoast preservation facility arrangement plan need to be established in such a way that they are integrated with each other.

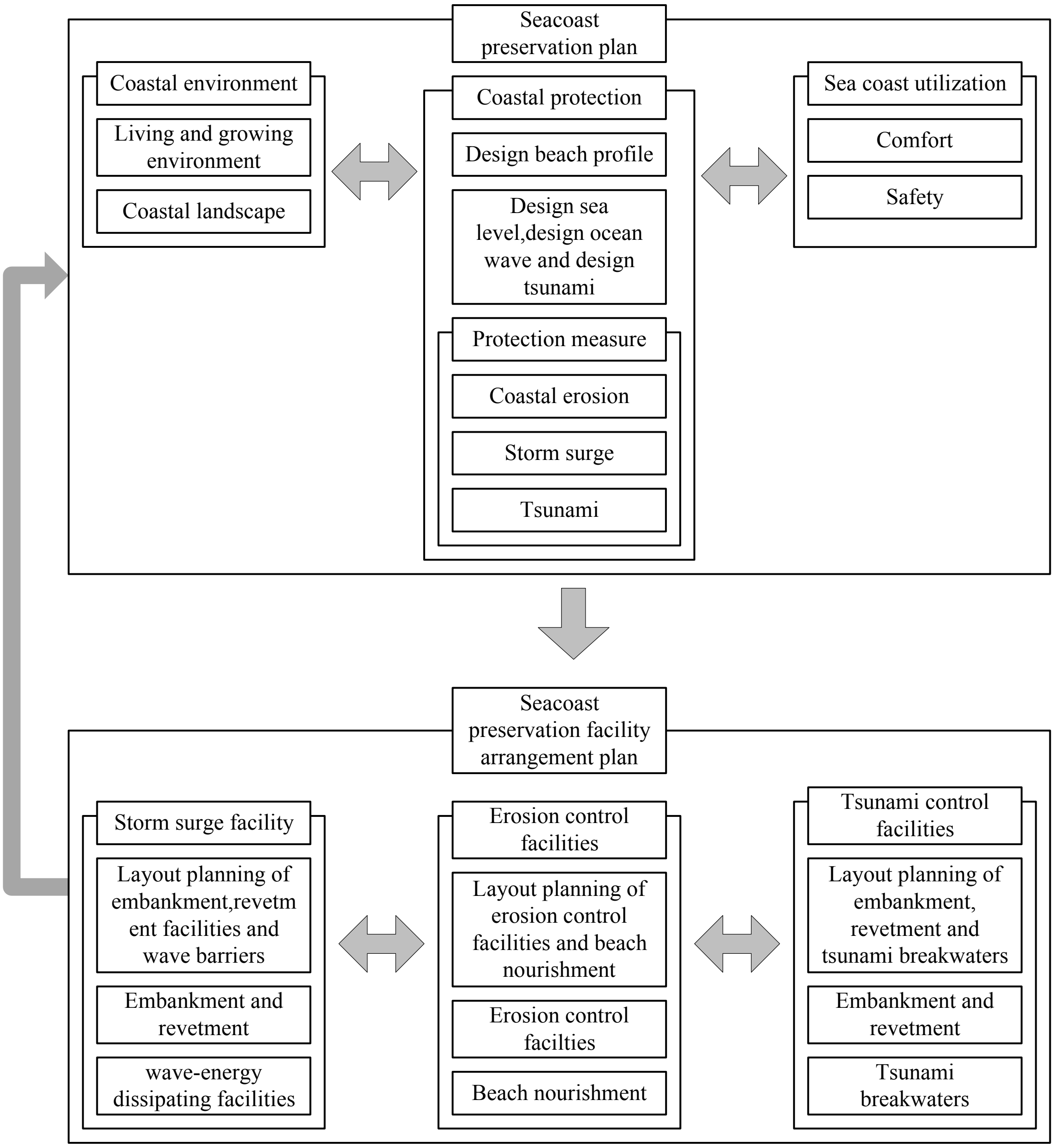


Fig.4-2 Organization and flows of plans

The aim of “Coastal protection” is to protect the lives and property of the general public from storm surges, tsunamis, and ocean waves, and to protect seacoasts, which are public assets, from erosion. The aim of “improvement and conservation of the seacoast environment” is to: conserve the diverse spaces themselves, including mud beaches, sandy beaches, shingle beaches, and cliffed coastlines, which form the substrate of ecosystems, history, and culture; to preserve coastal landscapes, which are historically and culturally important; and to improve degraded coastal environments wherever necessary. The aim of “Seacoast utilization” is to coordinate diverse overlapping or conflicting use purposes such as recreation, distribution, and fisheries, and to promote safe and comfortable seacoast utilization.

In a seacoast preservation plan, the terrestrial and marine areas that influence the seacoast are treated as one integral area. The plan should include measures to be undertaken in the seacoast preservation area by seacoast administrators as well as measures to be implemented through coordination with the people concerned from surrounding areas.

In many cases the protection line is set on the basis of the current shoreline when examining coastal protection. From the viewpoint of overall national land management, however, although the protection line seems to be regarded as a matter-of-course condition, its appropriateness needs to be reexamined in view of proper land use, etc.

A seacoast is an area with diverse natural conditions, including its meteorology, oceanographic phenomena, topography, and geology, etc. Social and economic conditions such as population, assets, and land use are different from one seacoast to another. Consequently, care must be taken not to design a seacoast preservation plan in a standardized manner, but to take into consideration the particular characteristics of each subject region.

Along a seacoast, natural processes such as ocean waves, tides, winds, and the activities of organisms are constantly taking place, and give rise to a particular coastal geomorphology and coastal environment. By valuing and making use of these natural processes, it is possible to preserve the natural habitat in good condition and to conserve and develop a safe and beautiful seacoast. For this purpose, in designing a seacoast preservation plan it is necessary to fully understand natural forces.

Seacoasts are generally divided into two types: 1) beaches composed of mud, sand, and shingle; and 2) cliff-lined coasts, with exposed base rocks and many reefs. Beaches are further classified into three types depending on their bed materials: 1) mud beach; 2) sandy beach; and 3) shingle beach. An extensive flat area composed of sand and mud with an intertidal zone is called a tidal flat. Sandy beaches, being the primary target of coastal protection, are where seacoast preservation facilities are often constructed or improved by seacoast administrators and where conflicts between coastal protection, environmental conservation, and use can easily occur. Figure 4–1 shows the functions of the sandy beach. In building or improving a seacoast preservation facility at a sandy beach, it is essential to understand that sandy beaches have important functions related to coastal protection, environmental conservation, and utilization, as they absorb the energy of waves, purify seawater, provide habitat for flora and fauna, provide spaces for recreation and sports, and work space for agriculture and fisheries.

Table.4-1 Functions and capabilities of the sandy beach

Purpose	Function	Capability
Profection	･Wave over topping prevention	Reduction efficiency of run-up height and wave overtopping rate, and stability of coast line
Environment	･Water puritication ･Living spase for plants and animals ･Landscape	Efficiency of purification, living conditions for plants and animals (grain size of bed material and water guality, etc)and landscape obstrucation(crest height, etc)
Utilization	･Swimming beach ･Fishing ･Place for festive events	Convenience(access time, etc),comfort (rrain size and color of bed material, water guality, etc)
Other	Foundation of structures such as embanlcments	Support strength of rock bed,scour rate and stability

The following items need special consideration in designing a seacoast preservation plan.

1. Consistency with related plans

Consistency with other related plans such as national land utilization or development plans and regional plans needs to be assured.

2. Cooperation and coordination with the administrative authorities concerned

Sufficient cooperation and close coordination with seacoast-related administrative authorities are necessary.

3. Community participation and information exchange

Seacoast-related information needs to be distributed widely during plan preparation to improve the transparency of the project and convey what the situation concerning coastal protection, environmental conservation, and utilization would be like as a result of plan implementation. Community members should be invited to participate in public hearings during both the plan development stage and the plan implementation stage as required so that the plan can be implemented effectively and efficiently.

4. Review of the plan as required

The achievements of the plan and construction or improvement of planned seacoast preservation facilities need to be reviewed as required. Any changes will depend on the results of the monitoring and will be in accordance with changes in the physical, social, and economic conditions of the subject region.

Section 2 Basic Items Associated with Coastal Protection

2.1 Overview

The aim of coastal protection is to mitigate damage to human lives and assets and impacts on various activities taking place on land owing to storm surges, tsunamis, ocean waves, and sediment regimes while maintaining harmony with the coastal environment and utilization.

A defined section of seacoast should be determined as the target area from the target external forces; the situation of the area prone to flooding due to wave overtopping or overflowing; and the continuity of beach drift.

This section describes the elements of a coastal protection plan as well as the basic policies of coastal protection against erosion, storm surges, and tsunamis. A coastal protection plan should provide comprehensive treatment of three aspects: erosion, storm surges, and tsunamis. In particular, it is necessary to examine the presence of erosion in order to confirm the adequacy of the design beach geometry elements on which storm surge and tsunami control measures are based.

Explanation

Under their severe natural conditions, including such phenomena as earthquakes, typhoons, low pressure systems, and winter ocean waves, the coastal areas of Japan are prone to disasters caused by tsunamis, storm surges, ocean waves, coastal erosion, etc., and many parts of Japan have actually received major damage in the past.

Figure 4–3 shows the place of coastal protection in a seacoast preservation plan. In a seacoast preservation plan, the goals associated with coastal protection, environmental conservation, and utilization should be set in accordance with the current situation of the subject seacoast. From these goals, the design ocean wave, design tsunami, and design sea level, which form the basic parameters of the seacoast preservation plan, should be determined, and the target coastal features should be determined as the elements of the design coastal form. Next, protection measures against coastal erosion, storm surges, and tsunami should be examined by using the plan's basic parameters. In this examination process, measures for dealing with coastal erosion, storm surges, and tsunamis need to be planned as a single integrated project, and there may be cases that call for reexamination as part of this process. If it turns out that no effective measure can be planned as a result of the examination, then a review of the goals of coastal protection, environmental conservation, and utilization may be necessary.

The development of countermeasures against coastal erosion, storm surges, and tsunamis requires a comprehensive examination, since control measures for storm surge and tsunami control are likely to differ depending on the target coastal features of the plan. For example, because the wave overtopping rate increases as the beach profile becomes smaller due to erosion, the elements of the design coastal form are a prerequisite for storm surge and tsunami control measures. Therefore, the long-term stability of the coastal features subject to protection (i.e. the necessity for a coastal erosion control measure) needs to be confirmed before developing a storm surge or tsunami control measure.

A coastal protection plan is part of a seacoast preservation plan, and the seacoast preservation plan must be a comprehensive, well-integrated plan in which measures for coastal protection, environmental conservation, and utilization are in harmony.

The design scale should be determined in consideration of past storm surges and ocean waves, the current status of the subject seacoast, the beneficial and adverse effects of the project, and the importance of the project area.

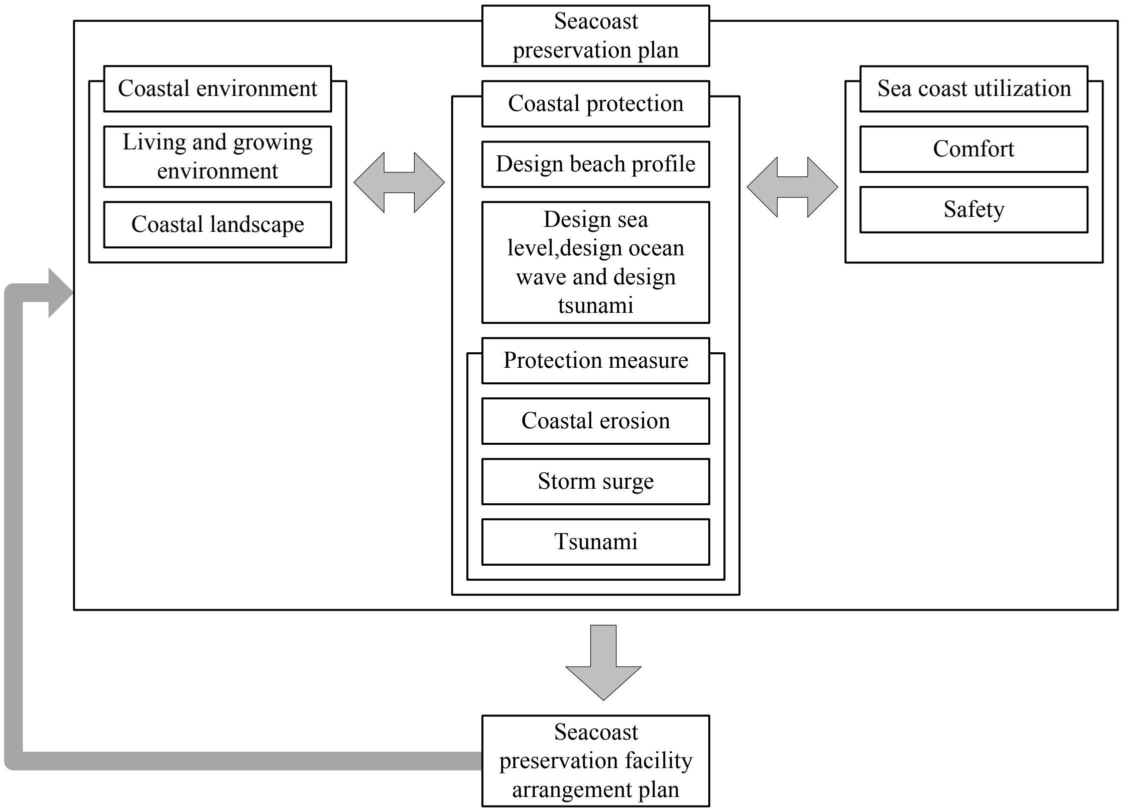


Fig.4-3 Positioning of coastal protection in a seacoast preservation plan

2.2 Factors of the design coastal form

The elements of the design coastal form should be determined as coastal features that are deemed necessary for coastal protection, environment, and utilization, based on an analysis of natural conditions such as meteorology, oceanographic phenomena, and topography, while taking into consideration the population, asset concentration, utilization, economy, etc. of the hinterland.

Explanation

The key elements of coastal form include backshore width, backshore height, foreshore width, foreshore slope, nearshore width, nearshore slope, and shoreline shape (Fig. 4–4). When determining the elements of the design coastal form, coastal features that are necessary for maintaining and improving the functions (protection, environment, and utilization) of the target seacoast should be determined.

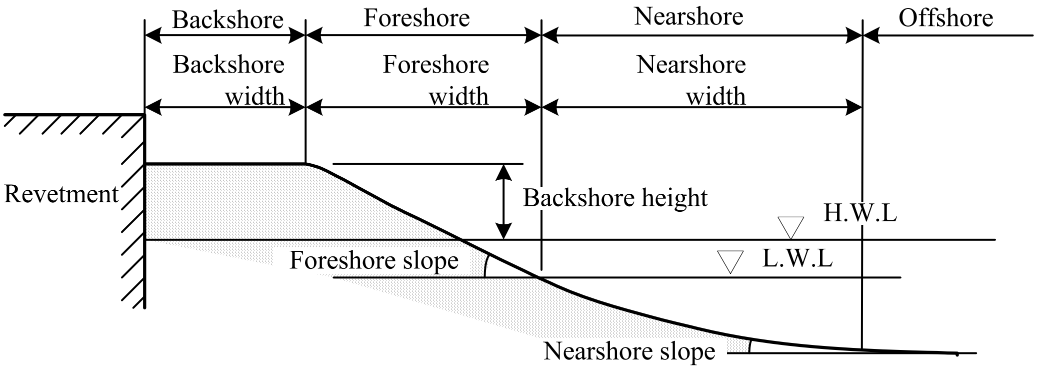
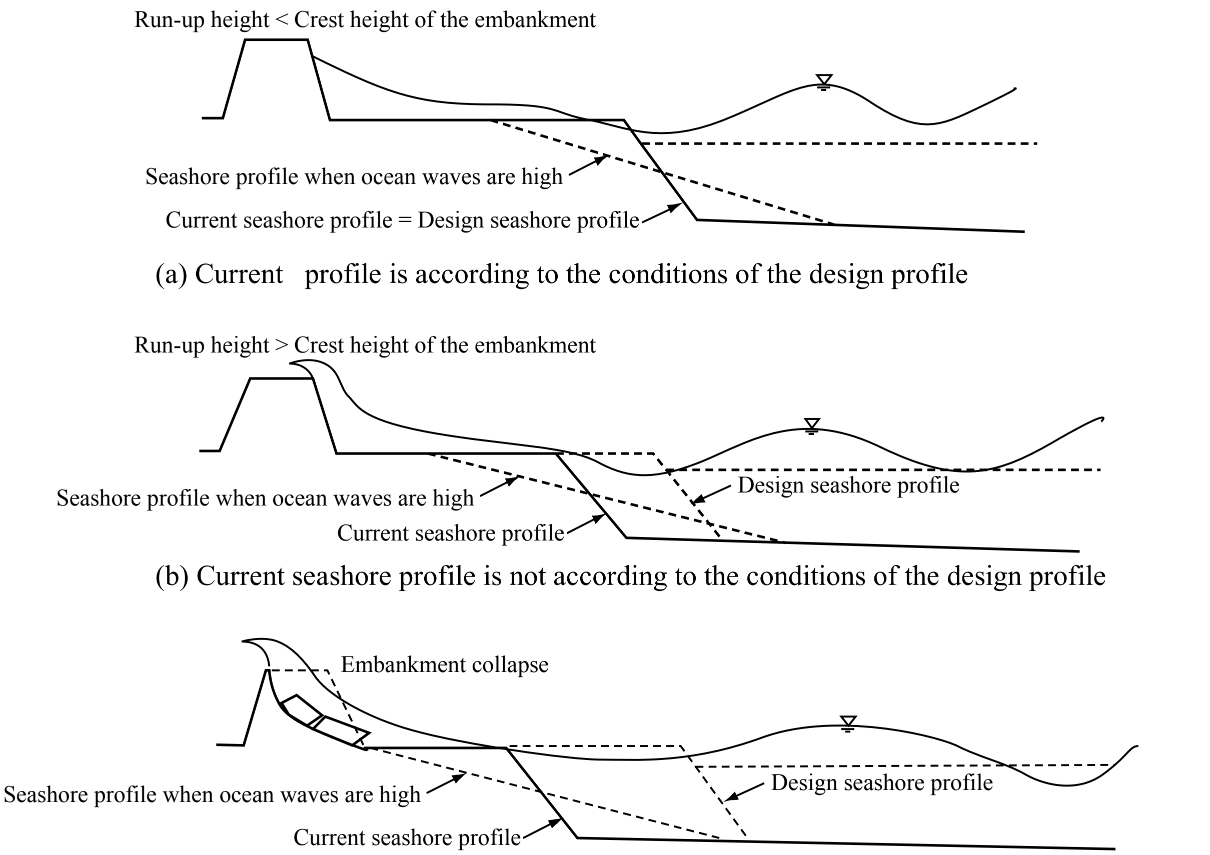


Fig.4-4 Elements of coastal form

In view of coastal protection, a shore sectional area, rather than individual elements of the coastal form, should be determined as the design shore elements in a storm surge or tsunami control measure in such a way that the run-up height does not exceed the design height (see Fig. 4–5). For coastal erosion control, the national land base line, the backshore width used as the foundation of the seacoast preservation facility construction, and the shoreline shape for control of the long-shore sediment transport rate should be determined. For coastal environment conservation, the necessary elements should be determined on grounds of the backshore width necessary for coastal vegetation and egg deposition, etc., Plant and animal habitat, and the coastal landscape. Elements necessary for a seacoast utilization measure should be determined based on the regional culture and livelihood as well as the number of seacoast users (see Table 4–1).

The sectional form of a shore constantly changes owing to short-term variabilities caused by ocean waves and tidal currents coupled with long-term variabilities such as erosion caused by imbalanced beach drift. In determining the design coastal features, a shore design that permits long-term stabilization should be assumed. The necessary elements of the design shore form must be ensured despite the predictable short-term variabilities. If the current shore elements are not effective in securing the elements of the design shore form, static beach nourishment may need to be considered to secure them.



(a) Current profile is according to the conditions of the design profile

(b) Current seashore profile is not according to the conditions of the design profile

(c) Current seashore profile is unmatched to the conditions of the design profile remarkably

Fig. 4-5 Concept of the design seashore profile

If the design shore form dimensions cannot be met by the application of a coastal erosion control measure, or if they are insufficient as storm surge or tsunami control measures, then the design shore form elements or the goals for coastal protection, environmental conservation, and utilization should be revised.

2.3 Design sea level

The design sea level should be determined based on tides, storm surges, seiches, secondary oscillations, etc. The frequency, period, duration, etc. of waves must also be taken into consideration.

As a general rule, the design sea level should be one of the following:

1. Maximum high water in the past
2. High water + Largest sea level departure from normal in the past
3. High water + Estimated largest sea level departure from normal

In cases 2 and 3, corrections can be made based on the frequency with which high water and largest sea level departure from normal occur simultaneously.

Explanation

Among the design sea level determination methods listed above, in cases 2 and 3, high water during the typhoon season instead of high water can be used, as in the bays of Tokyo, Ise, and Osaka. When the estimated largest sea level departure from normal obtained from a prediction formula or simulation using past meteorological data is employed, the Ise Bay Typhoon is often used as the design meteorological condition. For areas that are presumably prone to receiving damage at extraordinary levels, such as Tokyo, Ise, or Osaka Bays, for example, the Ise Bay Typhoon and other past typhoons are used to create models, and the design meteorological condition is determined through storm surge simulations that assume several different courses. The provisory clause is stipulated to allow revision of the design sea level if, from past data, an examination of the frequency with which high water and largest sea level departure from normal occurred simultaneously necessitates it. This would be likely in such cases as when the design sea level drastically fails to meet the content of the actual plan.

2.4 Design ocean wave

The design ocean wave height and period should be determined from an estimate obtained from long-term measured values, wave prediction using long-term meteorological data, or measured values for a neighboring coast. In either case, significant waves should be used in principle.
The design wave direction should be the direction that is expected to most significantly affect the run-up height, wave overtopping rate, and the scale and stability of structures, etc.

Explanation

The design ocean wave should be a deep water wave and should be determined, as a general rule, from measured values. Generally, one of the following should be used as the design ocean wave for use in a storm surge control measure or structural design:

1. Largest measured ocean wave
2. Ocean wave predicted from an abnormal weather model
3. Probable ocean wave obtained through probability prediction based on statistical data estimated from actual measurements or past meteorological data

As a general rule, significant waves should be used for ocean wave extremal statistics. Actual measurements used for ocean wave statistics should preferably be those recorded over a considerable period of time (more than 10 years). However, since there are cases in which abnormal ocean wave occurrences are concentrated over several years, careful analysis is essential when deciding to choose an observation period from the available data. In cases where there is a lack of actual measurements, the following data or material may be used as supplements:

1. Values obtained by using measured data to correct predictions computed from meteorological data recorded over 30 recent years
2. Long-term estimates obtained through wave prediction from meteorological materials such as weather charts

When using measured data to correct estimates obtained from meteorological data, the measured data should be from at least 3 years of records and should include a considerable number of abnormal ocean wave events. However, if a wave is observed during an abnormal weather event that may or may not occur once in several decades, and if that wave exceeds the estimated value, then the observed value may be used to determine the design ocean wave. Any records of abnormal waves from outside the period used for the estimations based on meteorological data (e.g. before the period) need to be considered. Furthermore, if measured data and estimates are available for a neighboring coast that has similar submarine topography, meteorological conditions, oceanographic phenomena, and other natural conditions, then the wave for the subject coast may be estimated by using these materials as reference.

Depending on the submarine topography, tide level, or the way in which the coastal structures have been installed, the wave height reaching coastal structures may not be the peak for the design ocean wave. Consequently, it is necessary to consider waves that are lower than the design wave height.

When waves hit a coastal structure, those approaching perpendicular to the length of the structure are usually the most dangerous. However, if this is not the case—for example, when the properties of entering waves are largely dependent on the angle of entry, or if there is an interception, or if the wind area is limited in a bay—then the design wave direction must be one that most affects the stability of structures, etc.

The ocean wave data used as part of a coastal erosion control measure are the wave height and prevailing wave direction that yield the mean ocean wave energy based on actual measurements when the shoreline variability is within the normal range. If there are large seasonal variations, ocean waves may be determined for each season. If the variation is temporary, the maximum annual wave or waves hitting several times per year, as determined from actual measurements, may be used.

When examining coastal utilization, ocean waves should be determined depending on the use.

2.5 Design tsunami

The design tsunami should be determined through examination of past tsunamis in consideration of the beneficial and adverse effects of the project, the importance of the project area, etc.

Explanation

Because of the low frequency of occurrence of tsunamis, in many cases (except in some areas such as the Sanriku coastal zone) sufficient data and experience from past tsunami disasters are not available for use in designing a tsunami disaster prevention plan. In addition, the length of the tsunami recurrence interval to be considered in determining the design tsunami has not been clearly specified, and the frequency of occurrence and scales differ considerably from region to region. For this reason, the wave height of the design tsunami should generally be determined from examinations of past tsunamis and in consideration of the beneficial and adverse effects of the project. In some cases, the maximum run-up height of a past tsunami is used as the design run-up height.

Since tsunamis cause tremendous damage very quickly, when the project area is an area of high importance, an assumption should be made about the magnitude and hypocenter of the earthquake. From this assumption, and in consideration of the run-up height estimated through numerical simulation, the design tsunami should be determined. In cases where there are no reliable data available or where the coastal geometry or facility arrangement has been changed because of the installation of a new coastal structure, etc., then the same procedure should be followed. For a region that may be hit by a tsunami occurring in an inter-plate seismic gap, a tsunami assumed with a virtual fault model may be used, since the details of past tsunami events are not known in many cases.

Because tsunamis have extremely long wavelengths and their propagation even affects the submarine topography—including abyssal floors—non-ria coasts may also receive serious damage. Although tsunami disaster-prevention measures are usually designed from past tsunami marks, or heights, when a measure is developed from an assumed tsunami, tsunami deformation in shallow waters needs to be considered.
Because tsunamis are a low frequency phenomenon, there is no need to include the external forces targeted in measures against storm surges.

2.6 Basic policy for coastal protection

2.6.1 Overview

Coastal erosion, storm surges, and tsunamis should be considered in a comprehensive manner in designing a coastal protection measure. Coastal protection needs to be in harmony with the target coastal environment and utilization. The development of coastal erosion control measures must precede storm surge and tsunami control measure considerations, since the design shore form elements, which are preconditions of storm surges and tsunamis as well as of the coastal environment and its utilization, must be determined in the process of developing a coastal erosion control plan.

Explanation

A basic policy for coastal protection should define the goals and means of protection against coastal erosion, storm surges, and tsunamis. These should not be developed separately, but need to be designed as integral parts of a comprehensive measure (Fig. 4–6). As this flow diagram indicates, in developing a coastal protection measure, the design shore form and the current shore form should be compared, and the need for a coastal erosion control measure examined, to ensure that the design shore form elements, which are preconditions for storm surge and tsunami control plan development, are obtained. For a seacoast for which it has been judged that a measure is necessary, first, a coastal erosion control measure and then a measure for securing the design shore form should be examined. Next, it should be determined whether a storm surge or tsunami disaster prevention measure is necessary against the design tide level, the design wind wave, and design tsunami; if a measure is required, it should then be examined. At this point, if the measure is expected to adversely affect the maintenance of the design shore form, then the coastal erosion control measure needs to be reexamined. There may be cases in which the design shore form elements constrain the content of the measure against storm surges. In such cases there is a need to revise the design shore form elements and establish a more appropriate plan. ,The need may also arise to modify the design shore form elements in the process of developing a coastal protection-related plan in view of coastal environment conservation and utilization factors.

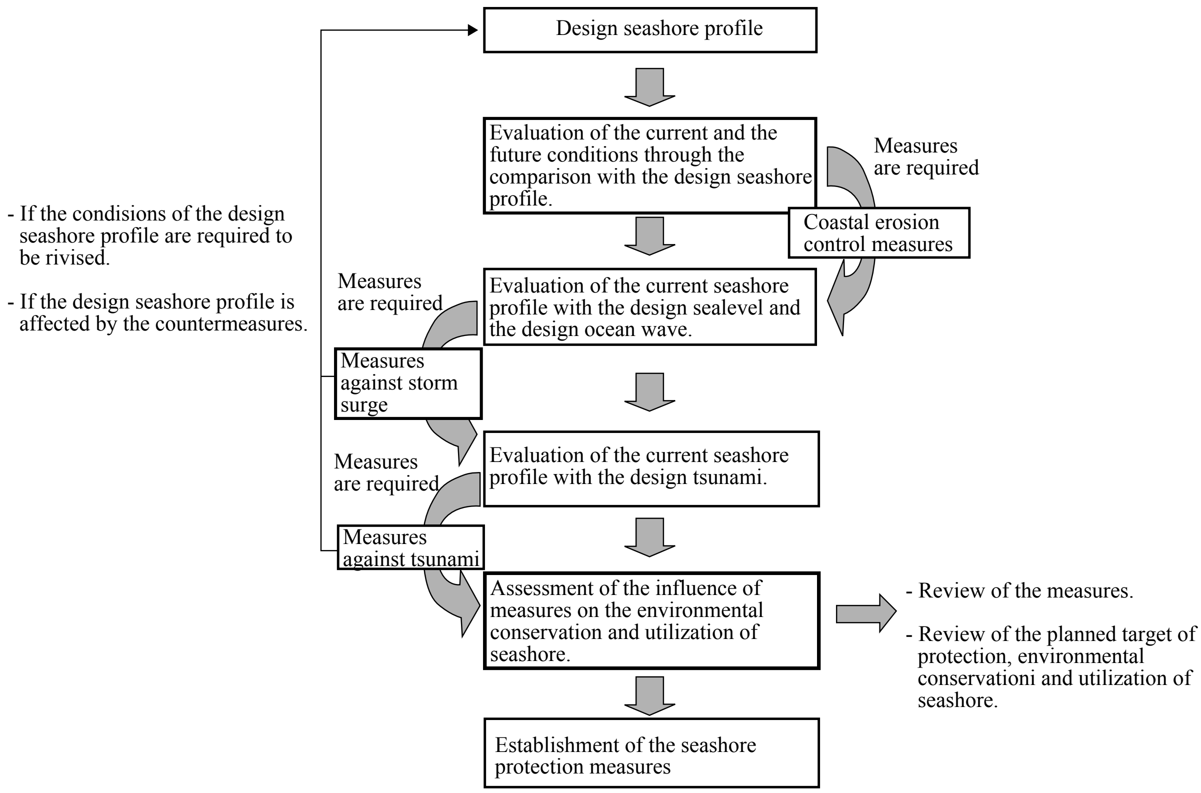


Fig. 4-6 Flow chart of the seashore protection planning

Through this process, a seacoast preservation plan should be optimized during its development with adjustments and coordination between measures against coastal erosion, storm surges, and tsunamis. The same optimization process through periodic examination is indispensable for coastal protection, environmental conservation, and utilization measures.

In particular, examination of coastal erosion to confirm the design shore form elements needed for coastal protection, environmental conservation, and utilization must be included as a precondition for developing any seacoast preservation plan.

2.6.2 Coastal erosion

A coastal erosion control plan aims to attain the design shore form elements, where appropriate, through (static) beach nourishment; improvement of the sediment regime; and preservation of the design shore form elements by ensuring well-balanced littoral sand drift through (dynamic) beach nourishment.

The project area, in principle, should be a littoral transport system, but it may include coastal land areas as appropriate.

Explanation

A coastal erosion control measure aims not only to prevent loss of national land and disasters caused by overflowing or wave overtopping, but also to pass down precious coastal environments to future generations and secure utilizable coastal spaces. To this end, the design shore form elements should be achieved through (static) beach nourishment. Equilibrium of sediment transport rate should be restored through sediment regime improvement, construction of a littoral transport control facility, or (dynamic) beach nourishment so that the design shore form elements can be preserved.

Figure 4–7 shows the typical flow of coastal erosion control planning. In designing a coastal erosion control plan, it is necessary to first specify a littoral transport system with a closed sediment budget, except in cases where the sediment is discharged to a submarine canyon or deep sea. Figure 4–8 shows the pattern of the sediment budget in a littoral transport system. The primary contents of the sediment budget in a littoral transport system are: 1) sediment supplied from the river and cliffs; 2) sediment discharged out of the zone as blown sand; 3) sediment flowing in or out the zone as littoral drift sand; 4) sediment flowing in or out the zone as cross-shore drift sand; 5) sediment discharged to a submarine canyon or the deep sea; and 6) sediment artificially moved out of the zone.

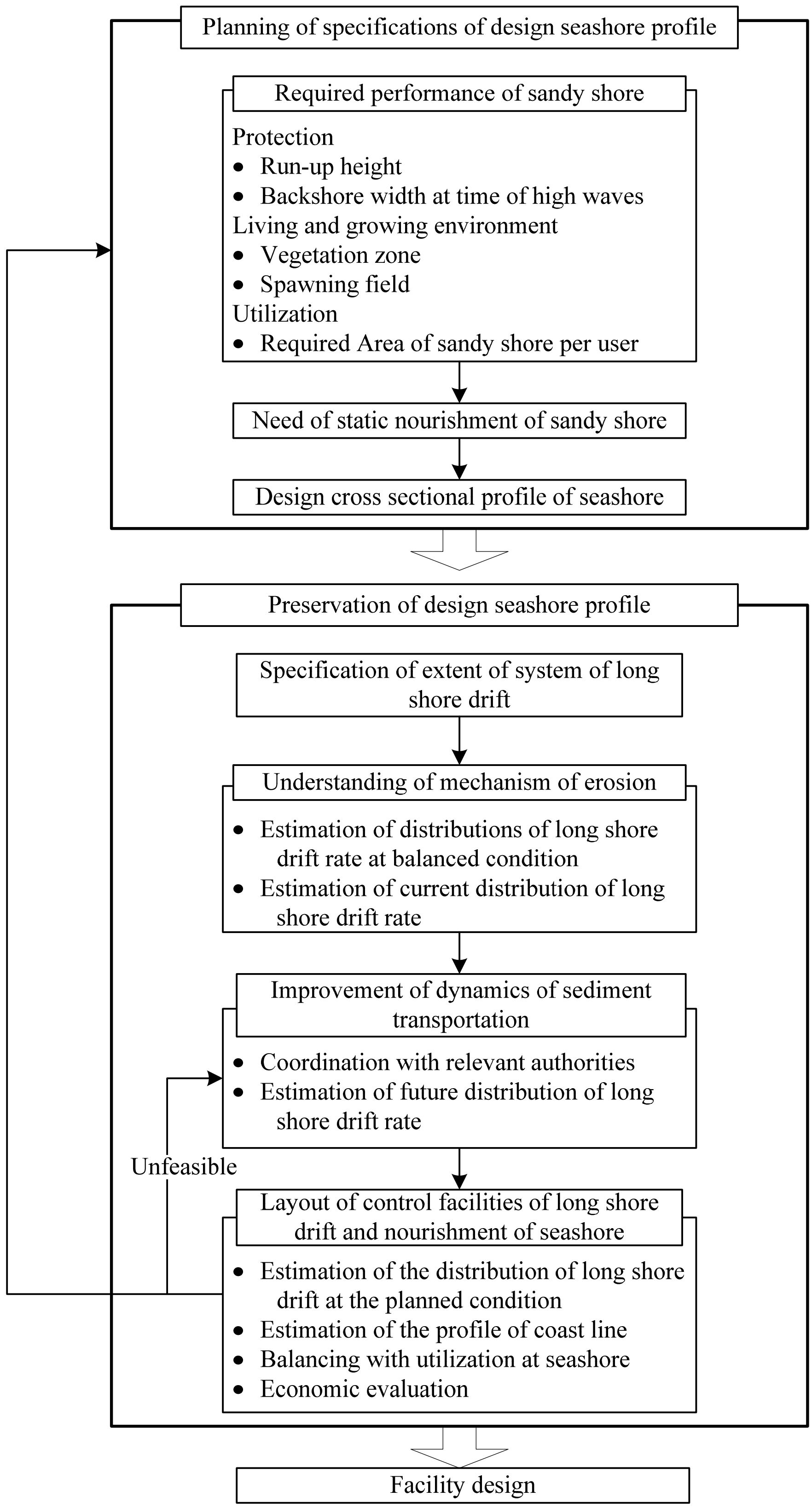


Fig.4-7 Flow chart of erosion control planning

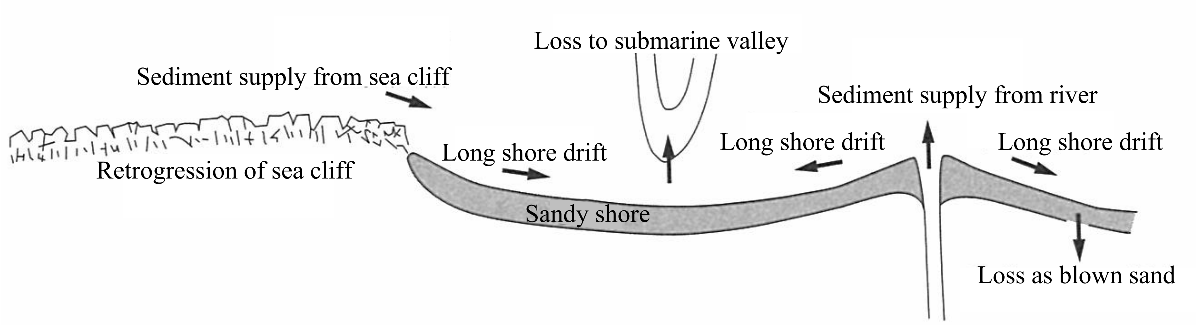


Fig.4-8 Schematic diagram of sediment balance of seashore

Next, from the status of past and present sediment budgets, the erosion mechanism should be elucidated, efforts to improve the sediment regime should be made through coordination with relevant organizations and bodies, and a future target sediment regime should be set. To this end, it is important to grasp the sediment regime evolution as a longshore sediment transport rate distribution or a sediment budget. The sediment regime should be investigated at points above and below the point where sediment change its features as a results of flows into the target littoral sediment transport system, the point where sediment is discharged out of the system, and the point where littoral sand drift is changed by a coastal structure, etc.

Because changes in coastal topography due to impacts such as environmental changes (e.g. changes in wind waves and sediment supplies) may be delayed, occurring over an extended period of time, an erosion mechanism is often associated with multiple factors from different generations. When investigating an erosion mechanism, the history of the sediment environment of the river basin and coastal zone must be examined and analyzed in a comprehensive manner, and the sediment volume supplied to the coast and the littoral sediment movement must be elucidated.

In cases where improvement of the sediment regime only is not effective for maintaining the design shore form elements from social and economic points of view, these elements must be maintained through the construction of a littoral sediment management facility or (dynamic) beach nourishment. The feasibility of installing a planned sediment management facility and using (dynamic) beach nourishment measures should be examined from economic and environmental viewpoints. If they are not feasible, then these measures should be reexamined and the design shore form elements and the goals for coastal protection, environmental conservation, and utilization should be modified as appropriate.

In examining a series of coastal erosion prevention measures, it is necessary to harmonize the measures with factors related to the coastal environment and utilization and to take full advantage of the various properties of the target seacoast.

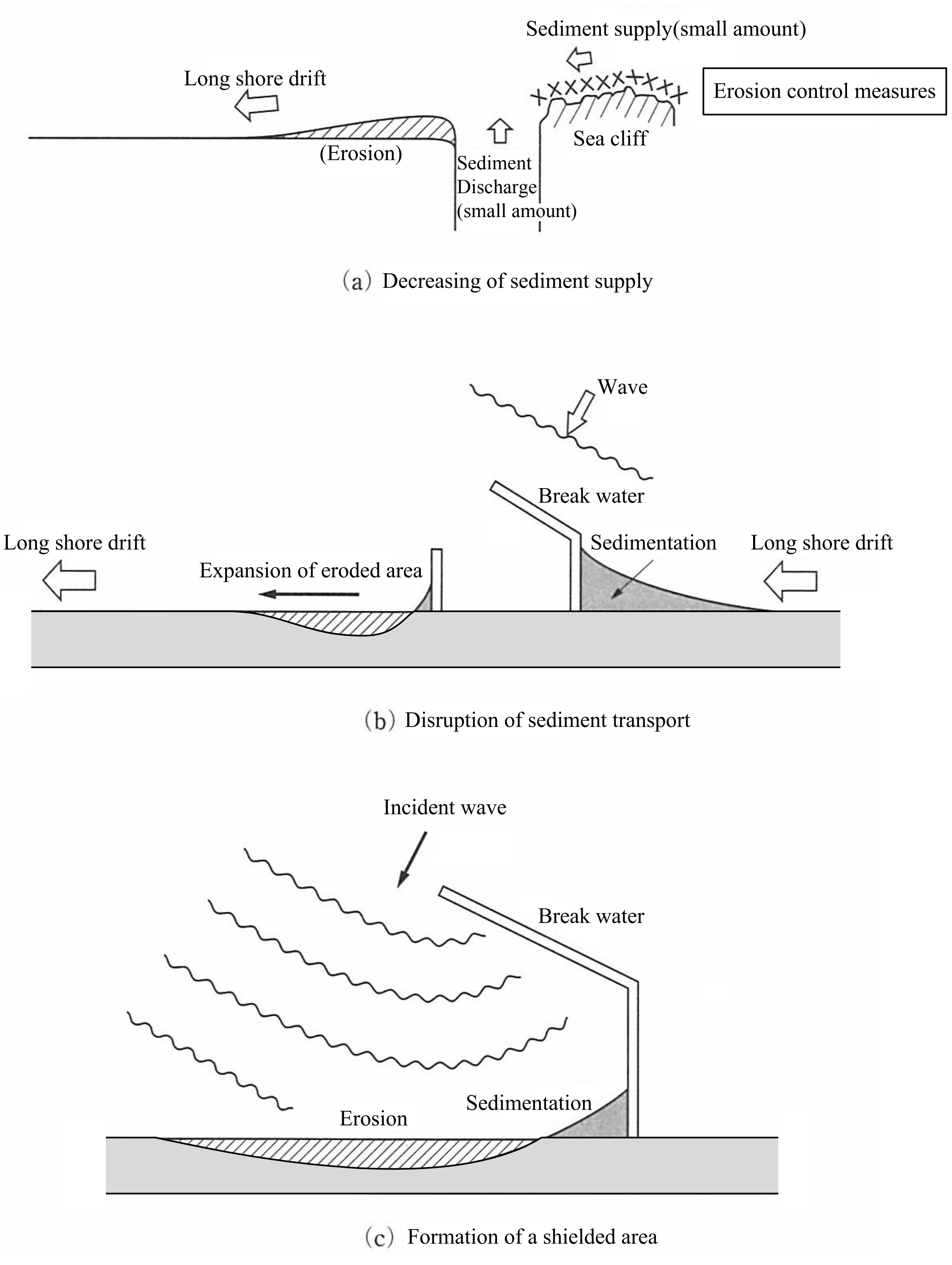


Fig.4-9 Patterns of coastal erosion

Coastal erosion is caused mainly by land subsidence or imbalances in longshore sediment transport. Erosion caused by the latter may arise from the following mechanisms:

1. Reduction of sediment supply from rivers and coastal cliffs (Fig. 4–9 (a))

Sediment discharged from river mouths decreases because of various factors, such as the presence of erosion control dikes located in the upper reaches of rivers that discharge into the subject seacoast, sedimentation in dams, reduced sediment discharge associated with reduced flood frequency, increased sedimentation in the river owing to the presence of groundsills, etc., and decreased river sediment loads due to gravel quarrying. In a seacoast that has been maintained by sediment supplies from coastal cliffs, coastal cliff erosion control measures will cause a sediment budget imbalance, resulting in erosion.

2. Disruption of littoral sand drift continuity (Fig. 4–9 (b))
If structures such as a breakwater, training dike, landfill revetment, jetty, or offshore dike are installed in a seacoast where littoral sand drift is prominent, then part or all of the coastal sand drift will be blocked and erosion will occur down current of the structure.

3. Dredging and gravel quarrying
If excavation is undertaken offshore by dredging of navigation channels or estuaries, or by gravel quarrying in an estuarine or sea area, drift sand may be trapped in the excavation marks, or beach profile changes that fill the excavation marks may occur, resulting in erosion.

4. Shielded area formation (Fig. 4–9 (c))
Even on seacoasts with little littoral sand drift, where the wave approach angle is almost perpendicular to the shoreline, a shielded area is formed behind a large-scale breakwater or pitched island installed in the sea area. Sediment moves from the outside to the inside of the shielded area near the shore, resulting in erosion. On the other hand, on seacoasts with little apparent sediment transport due to seasonal variation in the wave approach angle, the sand drift direction is not reversed even when the wave direction is reversed within the shielded area. Therefore sediment deposited as a result of littoral drift sand being blocked by the anthropogenic structure cannot move out of the shielded area. This causes an imbalance in the sediment transport rate, facilitating the rapid development of erosion.

Since the short-term changes on a beach dominated by cross-shore sediment transport are, in most cases, reversible processes, and can be treated as probabilistic, the variability range should be reflected in the elements of the design shore form. In addition, since the occurrence of non-reversible cross-sectional changes has been confirmed, care must be taken when interpreting the results of actual section measurements.

2.6.3 Storm surge

A storm surge control plan aims to prevent wave overtopping and inland seawater flow by using embankments and wave dissipation structures for the design tide level, design wind wave, and design shore form elements, thereby protecting human lives, assets, and activities in the area subject to protection.
The mitigation of disasters caused by external forces exceeding the design scale should also be counted.

Explanation

Storm surge countermeasures are aimed at preventing disasters caused by storm surges and high wind waves.

The “storm surge” phenomenon is an abnormal rise of the tide level in marine coastal areas because of barometric depression and winds caused by typhoons, low pressure systems, etc. However, “measures against storm surges” target both abnormal tide levels and high wind waves caused by strong winds. Patterns of damage caused by storm surges and high wind waves are classified into the following two categories: 1) damage from flooding in the sheltered area due to wave overtopping and inland seawater flow, and 2) damage caused by the energy from the overtopping sea water and by inflowing objects. The objects to be protected can be divided into three categories: 1) human lives, 2) assets, and 3) activities such as business activities and transportation.

In most cases, the milder a coastal slope is, the greater the wind setup becomes. Seacoasts with mild slopes, such as those of the bays of Tokyo, Ise, and Osaka and the Sea of Ariake, have historically received serious, large-scale storm surge disasters. On the other hand, on seacoasts such as that of Suruga Bay, which is characterized by a steep submarine topography, although the wind setup is comparatively small, because storm surges can approach without being attenuated by the submarine topography, the embankments needed are higher than for the aforementioned enclosed bays.

The preliminary basic research that must be performed before a storm surge countermeasure is developed should be conducted as described in the Research volume on Technical Criteria for River Works (Proposal). Not only natural conditions, such as climate and oceanographic phenomena, but also social conditions such as the population and industries in the project area should be studied. In particular, disaster research needs to be aimed at grasping not just the hydraulic data but also detailed information on the actual situation so that it can be used effectively as the basis of determining the design scale.

It has been confirmed that wind waves attacking a seacoast at the time of a typhoon, etc. include long-period waves whose period is as long as several minutes, and these are largely assumed to be the cause for high run-up heights and wave overtopping. However, because there have not been sufficient data available to justify the quantitative treatment of long period waves, here, a storm surge countermeasure should be developed from the design tide level plus the effect of the design wind wave, as has been conventionally done. Efforts are needed to gather data to be used to grasp the characteristics of long period waves in accordance with the relevant descriptions in the Research volume.

Before a storm surge countermeasure is developed, coastal erosion should be examined to ensure that the design shore form elements will be secured.

In establishing a storm surge countermeasure, in view of the damage mitigation against external forces exceeding the design scale, not only structural measures of facility construction or improvement but also non-structural measures such as rapid information transfer for effective evacuation should be examined.

The content of a storm surge countermeasure needs to be harmonized with coastal environment conservation and utilization factors so that various characteristics of the subject seacoast can be fully utilized.

2.6.4 Tsunamis

A tsunami control measure should aim to mitigate damage to human lives and assets as well as influences on activities in sheltered areas by the construction of a coastal dike designed in accordance with the design tsunami.

Mitigation of the damage from external forces exceeding the design scale should also be taken into consideration in the design of a tsunami control measure.

Explanation

A tsunami control measure should aim to prevent tsunami disasters. Patterns of damage from tsunamis can be classified into the following two categories: 1) damage from flooding in the sheltered area due to wave overtopping and seawater inflow; and 2) damage caused by the energy of overtopping seawater and from inflowing objects.

Surrounded by quake-prone marine areas, Japan has often received damage from tsunamis since ancient times. Tsunamis are caused by a sudden deformation of the sea floor and seawater surface (e.g. fault movement, topography failure, meteorite fall, etc.) and are often caused by submarine earthquakes. Tsunamis can be divided into two categories: 1) far field tsunamis that reach the coast in several hours after the occurrence, and 2) near field tsunamis that reach the coast within several tens of minutes after the occurrence. The frequency of large-scale tsunamis hitting a particular region is extremely low, although once they do hit, they cause destructive damage to the region, resulting in serious disasters. Although studies are being conducted on the characteristics of tsunami-causing earthquakes, so far there has not been enough progress to make it possible to predict the occurrence of tsunamis. On the other hand, seismic gaps at plate boundaries have been recognized as origins of the earthquakes likely to cause tsunamis.

To develop a tsunami control plan, research is needed into natural conditions such as the topography and social conditions such as the population and industries of the project area. When considering the establishment of an evacuation system, etc., it is necessary to investigate the land uses in the subject coastal area, including the suitability of coastal buildings to the coastal environment. Research on past disasters, in particular, needs to be aimed not just at gathering hydraulic data, but also at investigating the actual circumstances under which the data were collected. Since human memories and experiences of past disasters can easily fade with time, special attention should be paid to the collection and storage of data and materials as sustainable records.

In view of the need to mitigate the damage caused by excess external forces and establish risk management, there is a need to construct or improve coastal protection facilities such as embankments and breakwaters. There is also a need for comprehensive measures that combine these structural measures with non-structural measures such as the establishment of a disaster prevention system in cooperation with communities in the subject region; the securing of areas for evacuation and escape routes; evacuation guidance for users; and adjustment of land uses. Furthermore, the occurrence of earthquakes with relatively small tremors that cause major tsunamis (tsunamigenic earthquakes) needs to be taken into consideration in the design of prevention measures.

Since the occurrence of tsunamis is not associated with other oceanographic phenomena, measures for fast recovery after coastal protection facilities have been destroyed by tsunamis need to be established for seacoasts where storm surges or high wind waves often occur.

The content of a tsunami disaster prevention measure needs to be harmonized with coastal environment conservation and utilization factors so that the various characteristics of the subject seacoast can be fully utilized.

Section 3 Basic Items Associated with Coastal Environment Improvement and Preservation

3.1 Overview

The aim of coastal environment improvement and preservation is to protect or restore the ecosystem and landscape of the subject coast in harmony with coastal protection and utilization. Goals for coastal environment improvement and preservation should be based on the current and past status of the coast as well as the situation on neighboring coasts. The goals should aim to preserve and restore the diverse elements of the coastal environment, including beaches and cliff-lined coasts, while making efforts at consensus building among the parties concerned.

Explanation

Seacoasts are an interface between the land and the sea. They provide diverse habitat for animals and plants, such as beaches (including tidal flats) and coastal cliffs, and there are many indigenous animals and plants that are dependent on these peculiar natural conditions. There are also seacoasts where beautiful natural landscapes, such as those with white sand and green pines, are seen, or where natural parks are located. The primary environmental functions of seacoasts that need to be improved and preserved include: 1) a space for animals to live, breed and raise young; 2) biological and physical water purification; 3) physical and mental health improvement; 4) a space for environmental education; and 5) carbon dioxide sequestration function.

A coastal environment improvement and preservation plan should cover not only the subject seacoast preservation area but also the neighboring coast, hinterland, and offshore sea areas, whenever this is necessary.

In coastal environment improvement and preservation, behaviors that have adverse effects on the coastal environment should be avoided if at all possible. Efforts should be made to protect the coastal environment, and lost natural conditions and landscapes should be restored as required. To this end, construction or improvement of seacoast preservation facilities should be implemented in accordance with the natural characteristics of the individual seacoast. Also, in view of the need to procure living and growing spaces for animals and plants, it is necessary to examine the existing facilities with a view to rebuilding them to be friendly to the coastal environment.

As shown in Fig. 4–10, trade-offs may occur between coastal protection, environmental conservation, and utilization factors. In addition, because a coastal environment is composed of diverse elements, the value judgments of those elements are diverse. For this reason, if the target of the plan is limited to particular elements, the plan may adversely influence other elements and invite conflicts of value. To minimize these trade-offs and conflicts and set coastal environment goals sensitive to the natural and social characteristics of the subject area, it is important to build consensus between the concerned parties (seacoast administrator, local government, experts, community members) and implement preservation and restoration measures through their collaboration (Fig. 4–11).

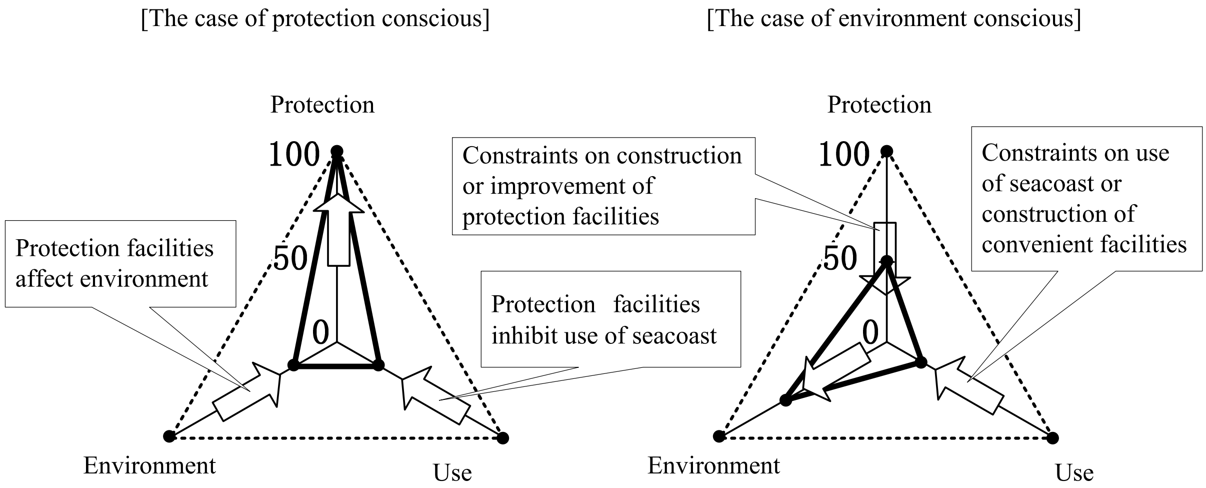


Fig.4-10 Trade-offs between coastal protection, environmental conservation and utilization

Data and information on the subject seacoast environment should be collected, documentated, and analyzed. By providing and publicizing the results, such data and information should be shared between the concerned parties to bring about a common understanding of the coastal environment to be preserved. Cooperation with other projects, establishment of a support network with experts and NGOs, and application of adaptive management, etc. are also important. In the process of developing the plan, the "Guidelines for Promoting Coastal Development in Symbiosis with Nature" would be a useful reference.

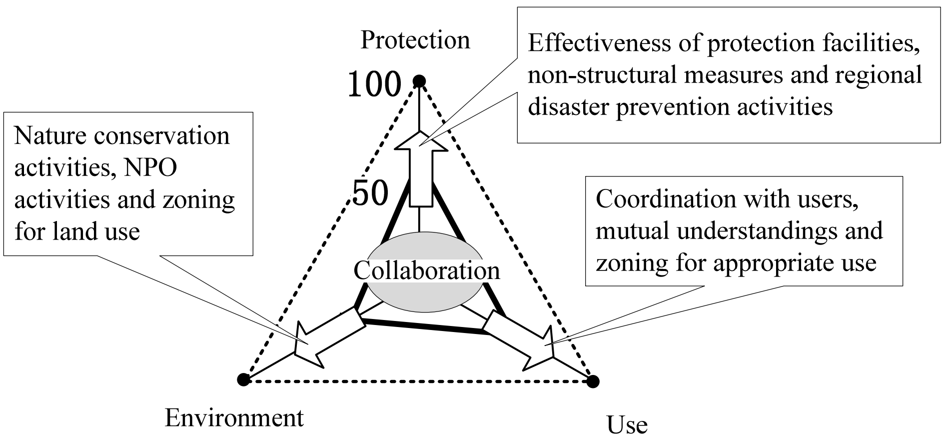


Fig.4-11 Seacoast development well-balanced in protection, conservation and utilization

3.2 Preservation and restoration of hospitable habitat for animals and plants

Plans or measures for the preservation and restoration of sustainable habitat for animals and plants should be designed from research conducted in the past or in the course of plan development. The plans or measures should aim to preserve a highly stable living and growing environment to sustain diverse fauna and flora. Efforts should also be made to restore the environment if this is necessary.

Explanation

Preservation and restoration of sustainable habitat for animals and plants should be evaluated from the following three points of view: 1) stabilization of sustainable habitat for animals and plants; 2) smooth matter cycle; and 3) biodiversity.

1. Stabilization of sustainable habitat for animals and plants

Such habitat should be regarded as having been stabilized if utilized by indigenous species with no significant decrease or increase in the number of individuals for several years or longer, or if the numbers of individuals of those species match the constituent ratios appropriate for the habitat. Because changes in the situation of a habitat greatly influence the species living in that habitat, the degree of balance between the factors forming the habitat, the bed material and water quality, and other significant factors should be determined.

2. Smoothness of material cycle

The material cycle mechanism should be comprehensively elucidated from an examination of various components, including inflow from rivers, seawater exchange volume, biological production volume, internal production rate, settling volume, solution volume from the sea floor, solution rate, etc.

3. Biodiversity

The degree of biodiversity should be determined from the numbers of indigenous species higher and lower in the food chain in the habitat. In this process, not only the variety of the entire biocenosis but also the varieties of indigenous species and their abundance as a proportion of the entire community should be considered, and it is also necessary to take heed of rare species, the coastal environment status, and the conditions enabling preservation of region-specific species.

Depending on the substrate material, seacoasts are categorized as mud beach, sandy beach, shingle beach, coral reef, or cliffed, and each habitat has a peculiar ecosystem with different characteristics. For example, sandy beaches, provide egg-laying and nesting habitats for animals such as sea turtles and little terns. Mud beaches provide habitat for a diverse range of organisms and feeding sites for wild birds. Seaweed beds and forests support the basic production of the marine food chain and also provide spawning sites and shelter for fry. Furthermore, seacoasts are composed of zones parallel to the shore: offshore, nearshore, foreshore, and backshore. The functions of these zones, whether for breeding, growing, or living, depend on the space, and different spaces are closely interrelated. An ecosystem is formed thanks to the presence of these diverse spaces, and therefore it is important to understand their ecological functions and how they are related to each other as a network.

Ecosystems contain an extremely wide variety of species, and it is not possible to grasp them all. An effective approach is to select a target species or community that has an important function or can act as an indicator for preservation of the entire ecosystem and then examine the preservation of the community or species.

It is impossible to grasp any ecosystem thoroughly, and because of the uncertainty it is also impossible to predict all influences. For this reason, it would be effective to adopt adaptive management for correction as needed, while using monitoring to identify effects and influences.

In the case of the use of cars on a beach or spoilage of the beach by the trampling of habitat, which can destroy habitat for animals and plants, it is necessary to consider restrictions on when and how the beach should be available to users.

It is not possible to quantify the effects of coastal protection facilities on an ecosystem. However, the extinction of coastal vegetation and destruction of nesting sites for sea turtles have been reported from the construction of sea embankments and revetments. Detached breakwaters have been reported to obstruct turtle access to the beach for nesting. On the other hand, the presence of reef organisms on or around detached breakwaters, seaweed propagation on the crowns of man-made reefs, and the presence of fish around new types of detached breakwaters have also been reported. In designing a coastal protection facility construction or improvement plan, it is necessary to examine records of past cases to determine how the plan or facility would influence the subject coastal environment.

3.3 Preservation and restoration of coastal landscape, etc.

Preservation and restoration of the coastal landscape should be viewed in combination with consideration for protecting forests, streetscapes, etc. in the hinterland. Efforts to preserve the landscape and its characteristic components, such as the sea surface, horizon, shoreline, and land area, should be made. Landscape restoration should be implemented if necessary.

Elements of coastal flavor, such as the sound of the waves and the tang of sea air, also need to be taken into consideration.

Explanation

Coastal landscapes, as typified by white sand and green pines, are deeply and extensively related to the formation of the culture and identity of Japan as a maritime country. At the same time, Japan is prone to natural disasters caused by such phenomena as storm surges, erosion, and tsunamis, and with extensive utilization of coastal land, disaster-prevention measures are indispensable for the stabilization of people’s livelihoods. For this reason, consideration of the coastal landscape was likely to have been lacking in the scope of disaster-prevention measures that were hastily established and implemented within limited budgets. A seacoast preservation plan must identify diverse values of the subject seacoast and comprehensively evaluate the coast’s values. It should also aim to preserve or restore the coast from these values.

The landscape of a natural seacoast is composed of the sea surface, islands in the sea, shoreline, and the hinterland as integral elements. Some coastal protection facilities may affect the water surface, horizon, coastal shape, and other elements of the natural seacoast landscape, reducing the coast’s value. For this reason, in selecting the type of coastal protection facility, it is necessary to fully understand the natural agents that form the coast and its value, and efforts should be made to preserve and restore the coastal landscape wherever necessary. Adjustable measures should be also necessary for preservation or restoration of the hinterland landscape.

There are also cases that necessitate the artificial creation of a landscape through proactive utilization of seacoast preservation facilities, etc. Since simultaneous landscaping of the hinterland is often required in many cases, special consideration is needed for integration with the hinterland. Furthermore, artificial formation of a landscape should also be based on an understanding of the natural environment and implemented within an

adaptive and controllable scale.
A seacoast influences people in various ways through their five senses, thus creating coastal values. The primary elements are the landscape, which is perceived visually; the soundscape, which is perceived aurally; and the tang of the sea air, which is perceived by the sense of smell. All of these contribute to the creation of an atmosphere that is unique to each individual seacoast. In principle, these elements should preferably be preserved as one unit.

Section 4 Basic Items Associated with Coastal Utilization

Coastal utilization should aim to secure safety, comfort, and convenience, depending on the characteristics and use pattern of the subject seacoast. The utilization function should be preserved and improved in harmony with coastal protection and environmental conservation.
Coastal utilization zones should be based on the coastal utilization pattern, and regulations and guidance for appropriate use by the general public should also be taken into consideration. For facilities used by the general public, user safety needs to be considered.

Explanation
Since ancient times seacoasts have been used for festive and other cultural events by regional communities. Seacoasts have played important roles in the formation and succession of regional cultures. With the recent advancement and diversification of people’s needs, seacoasts have been used for various types of sport and recreation, for experiential and learning activities, and for seaside healing and relaxation. They are also used conventionally as bathing spots.
Since seacoasts are prone to natural influences, their use has been limited. For this reason, installation or improvement of facilities that increase the convenience of use may be necessary to enhance the utilization function of seacoasts. Coastal convenience facilities include access to the seacoast, parking lots, public lavatories, rest areas, and information facilities, etc. In the installation of convenience facilities, the question of who will be the constructing or improving body and managing body needs to be considered.
In cases where access to the seacoast is hampered by the presence of a coastal embankment, access to the coast should be ensured by installing a stepped structure or a gently sloped embankment, as appropriate. In developing a plan for securing coastal access, barrier-free measures such as installation of a ramp should be considered so that the elderly and disabled people will have access to the seacoast. This will enable them to easily and comfortably visit the coast and come into contact with coastal nature in the course of their daily lives. Rubbish that has drifted ashore ranges widely from natural objects such as driftwood to anthropogenic objects such as plastics and resin pellets; enormous quantities of rubbish drift ashore. There is also illegal waste dumping and littering by coast users (e.g. empty cans, cigarette butts, fishing tackle, etc.). Since these interfere with comfortable use of the coast, the division of collecting responsibilities needs to be clarified among the parties concerned, and measures to enhance a sense of public responsibility among coast users and residents in river basins need to be implemented to control the generation of rubbish.
There are many cases in which the construction or improvement of coastal protection facilities and utilization conflict with each other, as exemplified by the construction of coastal protection embankments preventing access to the coast, or of detached breakwaters or artificial reefs preventing fishing or surfing. There are also problems

associated with harmonization between coastal protection, environmental conservation, and utilization, such as the destruction of coastal vegetation or nesting sites by vehicles driven on beaches. Moreover, friction arises from the simultaneous different use of beaches and coasts, for example, for sea bathing, surfing, jet skiing, fishing, etc.

In planning a coastal use adjustment measure, the functions necessary for the relevant community should be determined from the current uses of the subject coast and the needs of users. In consideration of the need for coastal protection and preservation of the coastal environment, conflicting uses of the coast should be coordinated with each other, safe use of the coast should be guided, and the coastal utilization patterns that meet the characteristics of the subject coast should be determined. It may also be necessary to restrict utilization for the purpose of coastal environment preservation.

When introducing a new coastal usage pattern, it is necessary to examine whether safe and comfortable use is possible in view of the natural properties of the coast; whether it will conflict with the existing usage pattern; and whether it will adversely influence the coastal environment. When a coast is used in multiple ways, the space and time for each usage should be specified to prevent accidents and friction among users.

In determining the coastal usage pattern and areas for use, opinions should be gathered from seacoast users, regional community members, fishery operators, and ecosystem experts, etc. whenever this is necessary.

Although a seacoast can be used by anyone freely at their own risk and responsibility, the natural conditions can lead to people being involved in accidents due to the occurrence of nearshore currents, sudden tidal waves, etc. When coastal protection facilities are made available for public use despite the risks, high safety levels should be ensured during the use of these facilities. This necessitates the incorporation of safety measures into the design of the coastal protection facility whenever such measures are deemed necessary in consideration of the external forces that are at work, the performance conditions, costs, and durability.

Some seacoasts may not be suitable for use because of their ocean currents, topography, and other natural conditions, or because coastal structures may have been built on them. Also, there are cases in which a seacoast may become dangerous because of the occurrence of tsunamis. For these reasons, the provision of sufficient safety information, education of seacoast users, etc., and cooperation with coast-related organizations and bodies are important for safe coastal utilization.

Reference

1) Guidelines for Promoting Coastal Development in Symbiosis with Nature. Written and edited by the Research Institute for Promoting Coastal Development in Symbiosis with Nature. Supervised by the Seacoast Office, Land Conservation Division, River Bureau, Ministry of Land, Infrastructure and Transport (MLIT) of Japan. Issued by the National Seacoast Association, p. 73, 2003

Chapter 5 Information Sharing and Cooperation with Communities in River Basins

Section 1 General Information

Water and sediment management needs to be implemented in close cooperation with organizations and bodies and concerned parties in the subject river basin. Such management exceeds the sole capacities of administrators and corporations associated with the river. With changes in the riparian environment, the increasing interest of the general public in administrative information, and the advancement and promotion of information technologies, we are facing a new challenge for the realization of a society where shared water-related information is readily available. In view of this arising social demand, it is vitally important to promote the establishment of a safe country with diverse cultures through the sharing and utilization among members of the general public of all types of water- and sediment-related information that are collected and organized.

Explanation

The goals of the basic policy described in Chapter 1 cannot be attained through the sole efforts of the administrators of rivers, sediment and erosion control measures, and seacoasts, or of related corporations. It is therefore important to establish cooperative and collaborative relationships between the organizations and bodies in the river basin as well as with concerned parties. It is also important to monitor changes in the natural and social conditions in the basin and to implement various projects in concert with all related parties.

Water is indispensable for all life and is a vital resource for securing comfortable and cultural lifestyles for the general public, for promoting agricultural and industrial development, and for maintaining cleanliness in our daily lives.

For this reason, the numbers of people seeking a sound water environment and the level of public concern for water-related information have been increasing in recent years.

In the 21st Century, further changes in the global environment relating to water and resulting problems from the viewpoint of securing a healthy water cycle are anticipated. These changes include the occurrence of heavy, intensive rainfall events that exceed the design scale because of the wider variability of the meteorological environment (attributable to global warming, etc.); unexpected disasters; exacerbation of desertification; and the occurrence of acid rain. They also include a reduction in the amount of water usable as a resource, and water shortages. In addition, water safety is at risk because of the diffusion of toxic substances such as dioxin via water.

With its steep mountain ranges and frequent typhoons, Japan is in a geographic and meteorological situation whereby it must be consistently prepared for flood disasters, droughts, and sediment disasters, etc.

With the adoption of the recommendations of comprehensive studies on the revision of official school curriculum guidelines, contributions from the disclosure of river-related data on hydrology, water quality, and ecological systems are expected.

Also, from the viewpoint of preserving a healthy water cycle, river basin administrators are seeking the integrated management of water-related information, such as on water intake and discharge and groundwater.

Thanks to the recent improvement of information infrastructure (e.g. by the construction and expansion of fiber-optic networks) and the advancement of new technologies such as GIS and GPS, the provision and disclosure of information to the public have been accelerated, and an environment for providing enormous amounts of visual and other data to the general public in an easy-to-understand manner is now taking shape.

The general public is now demanding a higher standard of river administration services, including streamlined administrative structures, more efficient river management through proper implementation of information gathering and management, and the realization of accelerated and transparent tendering and contracting procedures.

In view of this situation surrounding river administration, we need to develop more advanced and efficient river administration services that will enable the sharing of water-related information by the general public.

Section 2 Cooperation for Disaster Prevention and Mitigation

2.1 Overview

The current status of flood control facilities in Japan has not reached a satisfactory level. A huge amount of expenditure over a prolonged period is required before sufficient flood control at the design scale can be achieved. Since water and sediment disasters are caused by natural phenomena, there is always a risk of disasters occurring that exceed the design scale.

Cooperation with communities in the river basin can bring more economical and effective results than when flood control facilities only are used. For these reasons, to mitigate damages to human lives and assets by water and sediment disasters as much as possible, and to promote river improvement and sediment disaster prevention and coastal protection works, flood control measures that aim to reduce flood runoff volumes, minimize flood damage and the damage caused by storm surges, tsunamis, wind waves, and sediment disasters, and establish evacuation systems must be developed and implemented in cooperation with communities in the subject river basin.

Development and implementation of flood control measures in cooperation with communities in the river basin cannot be realized through the efforts of river administrators alone. It is indispensable for these administrators to collaborate closely with other administrative organizations and bodies involved in land use, city planning, sewerage, housing, agriculture, and forestry as well as communities in the basin and the mass media, etc.

Explanation

In planning measures for disaster prevention and mitigation, it is always necessary to take into account the possibility that external forces leading to events exceeding the design scale of the flood control facility may occur. This is because the collection period of hydraulic and hydrological data on which planning is based is a little over 100 years at most, and therefore not long enough to enable prediction of the most extreme events with long return intervals. Another reason is that using flood control facilities alone against external forces of extraordinary scale with low probability of occurrence requires more land and facilities than using flood control facilities in combination with measures implemented by communities in the river basin. The former approach is not necessarily economic or efficient.

For this reason, it is necessary to actively exchange sufficient information on flood disaster countermeasures with relevant organizations and bodies, community members, mass media, etc. during normal times, and, at the same time, it is important to promote due consideration of disaster prevention in land use and city planning. It is also necessary to establish information sharing and cooperative systems to smoothly carry out flood prevention and evacuation activities in times of disaster.

For example, in future development and land use planning it is important to consider preserving the water retention and retarding functions of the river basin. In addition, it is necessary to establish appropriate role sharing among communities in the river basin and to actively plan and implement measures over the entire river basin, including the securing of storage and infiltration functions coupled with city planning.

For a region with a concentration of population and assets, it is desirable to also consider the promotion of city planning in combination with the installation of flood- and earthquake-resistant embankments of a high standard that allow easy access to the river and maintain high scenic value.

2.2 Measures in flood runoff areas

To control increases in runoff due to development in the river basin, measures to optimize storage, infiltration, and retention functions inherent to the flood runoff area should be actively promoted in cooperation with communities in the basin.

Explanation

Measures in flood runoff areas include, among others:

- the preservation of natural land uses (such as forestry and agriculture),
- the maintenance of retarding areas (such as paddy fields),
- the introduction of facilities that promote rainfall infiltration (such as permeable pavements and permeation-type sewerage systems),
- the storage and utilization of rainwater, and
- the installation of reservoirs for flood disaster prevention.

To reduce flood runoff volumes, these measures in the flood runoff areas must be actively promoted in cooperation with communities in the river basin.

2.3 Measures in flood-prone areas

To mitigate disasters caused by flooding, measures for controlling flood flows and maintaining flood-retarding functions should be actively promoted in cooperation with communities in the river basin.

Especially in regions and facilities that make use of underground areas such as underground shopping areas, underground railroads, and basements (since these areas are at high risk of serious damage and fatalities), subsurface construction and underground utilization and improvement that take inundation into consideration should be promoted, together with the construction and improvement of inundation prevention and emergency drainage facilities and the establishment of evacuation systems.

Explanation

Measures in flood-prone areas include measures enabling residents to protect themselves, non-structural measures, and measures for subduing flood flows. Flood-flow control measures include the construction of ring levees, secondary levees, open levees, overflow-resistant levees, roads with raised heights, tree belts, and flood prevention forests. Direct self-protective measures include residential land raising, construction of houses with elevated floors, installation of watertight doors, and possession of emergency boats. Non-structural measures include the introduction of inundation-tolerant land uses, establishment of warning and evacuation systems, and obtaining water damage insurance. To mitigate damage due to flooding, these measures should be actively promoted in the flood-prone area in cooperation with the communities in the river basin.

2.4 Flood fighting

A flood fighting measure allows the maximum utilization of flood control facility functions and is extremely important for flood disaster mitigation. The primary responsibility for flood fighting rests with municipal governments (or district flood fighting authorities or flood-fighting associations). However, since effective and appropriate flood-fighting activities are impossible without the cooperation of river and seacoast administrators, close collaboration between municipal governments, district flood fighting authorities, flood-fighting associations, and river and seacoast administrators is necessary in all phases of flood fighting. At the same time, river and seacoast administrators need to proactively participate and be cooperative in the establishment of flood fighting plans from a broad-based point of view so that flood disasters extending beyond the territories of municipalities and prefectures can be properly dealt with.

River and seacoast administrators should promote, in an appropriate manner, the securing of resources needed for flood-fighting activities conducted in times of flood disasters, as well as the improvement of emergency response centers. In addition, they need to develop and install flood and storm surge forecasting systems, and (due to the Flood Fighting Act) issue timely and effective flood warnings.

Explanation

River and seacoast administrators must proactively participate and cooperate in designing the contents of flood fighting plans. To properly deal with flood disasters that extend beyond the territories of municipalities and prefectures, these administrators must determine important flood fighting locations and foster support and cooperation so that the flood fighting plans based on the Flood Fighting Act developed by related municipalities meet the requirements for prevention and mitigation of flood disasters. If the need arises to review the flood fighting plan because of river improvement, changes in the river channel status, etc., then administrators need to induce municipalities to revise their flood fighting plans as appropriate.

Flood and storm surge forecasting systems must be developed and installed, and efforts should be made to constantly enhance the precision and functions of the forecasting systems.

2.5 Evacuation

To protect people from being killed or injured in flood and sediment disasters, rapid and adequate evacuation

must be conducted if the public is endangered. To this end, municipal governments, river and seacoast administrators, and corporations that operate sediment managements—i.e. the bodies primarily responsible for regional disaster prevention measures—should work in close cooperation with each other.
For rapid and adequate evacuations, municipal governments, river and seacoast administrators, and corporations that operate sediment managements need to collaborate closely with each other to inform community members of flood-prone areas, areas in danger of sediment disaster, refuge routes, refuge shelters, etc., and establish evacuation systems in advance. Also, they should publicize the use of river terraces or other river spaces as evacuation routes and shelters in times of earthquake and should improve such spaces for these purposes.
In times of disaster, river administrators and corporations that operate sediment managements should prepare and announce, with appropriate timing, disaster forecasts such as the predicted arrival times of flood flows, inundation depths, inundation times, and predictions of damage from volcanic eruptions, etc.

Explanation

Information about changes in conditions in the river channel and basin such as facility construction or improvement and advances in technology always needs to be kept up to date.

River and seacoast administrators and corporations that operate sediment managements are expected to provide information on flood and sediment disasters and the like. Municipal heads are responsible for issuing evacuation orders and directives to their community members. Because they need to base their judgments on this information, it must be reflected in the disaster prevention plans developed by the municipalities. Operators of sediment managements also include corporations and public administrators of areas designated for erosion control works, landslide-threatened areas, and steep slope areas in danger of failure.

For the provision of disaster information, systems for directly providing the necessary information to community members should be established with the understanding and cooperation of the mass media and telecommunication companies, and by use of the Internet.

Since rapid and adequate evacuation is not possible if all community members lack an awareness of the risks, river and seacoast administrators and corporations operating sediment managements must provide community members with disaster prevention education during disasters and non-disaster periods alike.

Section 3 Cooperation for Appropriate River Utilization, Maintenance of Normal Functions of River Water, and Improvement and Preservation of the River Environment

3.1Cooperation for appropriate river utilization and maintenance of the normal functions of river water

Cooperation between local public bodies, relevant private organizations and bodies, and community members, etc. should be established to enable the entire river basin to promote measures for appropriate river utilization and maintenance of the normal functions of river water.
Water utilization measures in the river basin include measures against rainwater infiltration, storage measures, facility-based measures such as rainwater utilization, reuse of treated waste water, elimination and

consolidation of withdrawal and drainage systems, and measures for guidance on appropriate water utilization. In order for these measure to be efficiently and effectively implemented in the entire river basin, it is necessary to accurately grasp the local needs, ensure close coordination with relevant organizations and bodies, and consider appropriate role sharing.

Explanation

Appropriate river utilization and maintenance of the normal functions of river water require the participation of all groups within the river basin. It is also important that plans for future development and land use maintain the retention and retarding functions of the basin. At the same time, it is necessary to determine appropriate sharing of roles among the communities in the river basin and to actively promote measures involving the entire basin, such as measures for securing the retention and retarding functions, which are coupled with city or town planning.

To secure appropriate utilization of the river and maintenance of the normal function of the river water in cooperation with local public bodies, relevant private organizations, and local community members, etc., river and seacoast administrators should release and routinely exchange information related to the river, etc., with such groups as well as with citizens interested in the river, people with experience, academics, and other concerned bodies.

It is also important to establish a mechanism that allows smooth coordination through close cooperation and collaboration between participants to promote efforts by communities and entities in the river basin as a whole.

Examples of major structural- and non-structural measures are as shown below.

Structural measures

- Infiltration measure: Stormwater infiltration inlet, infiltration trench, etc.
- Storage measure: Facilities for rainwater storage, etc.
- Reuse: Utilization of rainwater, reuse of treated waste water (for miscellaneous, agricultural, or industrial use), etc.
- Elimination and consolidation of withdrawal and drainage systems
- Sewerage system improvement, pollution source control, preservation of water conservation forests

Non-structural measures

- Appropriate water utilization: Water conservation (by water consumers and water suppliers), rationalization of water utilization
- Guidance: Regulation, guidance, awareness raising, education, etc.

3.2 Cooperation for improvement and preservation of the river environment, etc.

To promote basin management for the preservation of natural environments such as river environments, and for the improvement and preservation of river environments as accessible environmental spaces, local needs should be accurately grasped and cooperation between local municipalities, relevant private organizations and bodies, and local community members, etc., should be established.

Explanation

In promoting the preservation of a natural environment and the improvement and preservation of river environments as accessible environmental spaces, cross-cutting measures for improvement and preservation of the environment of peripheral areas should be coupled with their utilization and preservation. This should occur through measures to improve and preserve the longitudinal river environment, as characterized by the continuation of water and vegetation in an upstream–downstream direction, as well as through cooperation with surrounding areas. To this end, it is important to implement river improvement and management by gaining the understanding and cooperation of the citizens, academics, and the bodies concerned. In an effort to determine what the ideal river environment should be like and to establish plans for river improvement and management, it is desirable to continuously release information on the subject river and to routinely exchange information and opinions with citizens interested in rivers, persons of experience or academic standing, and the bodies concerned.

Section 4 River Improvement in Cooperation with City Planning

In consideration of the land use, history, landscape, nature, climate, and culture of the basin, it is necessary to establish cooperation between local municipalities, relevant organizations and bodies, and regional community members to promote city planning that takes advantage of the characteristics of the river and provides places for regional interactions that make use of the river.

Especially in the case of urban rivers, consideration needs to be given to their multiple roles in addition to their flood fighting function, such as in urban disaster mitigation, providing an accessible environment, and supporting various urban activities.

Explanation

City and town planning for riparian areas requires autonomous local governments that play the major role in city planning to cooperate with river administrators.

In city planning, continuity as an integrated space consisting of the river and riparian area (e.g. topography, function, landscape, etc.) should be secured by taking advantage of the natural topography.

In river improvement, on the other hand, it is important to improve the functions of the environment and appropriate river utilization in addition to securing flood fighting functions.

Riverfront improvement should take into consideration the regional history, landscape, nature, climate, and culture so as to enliven the townscape in harmony with the riparian area and create a new attractiveness.

It is desirable to implement construction, improvement, and utilization measures by relating broad-based river-related plans to policies established by prefectures for the improvement, development, and preservation of city planning areas (City Planning Area Master Plans). Similarly, relationships with individual cities and towns should be associated with the basic policies established by municipal governments for city planning (Municipal Master Plans).

The following points need to be taken into account for plans and measures concerning urban rivers:

1. Securing of disaster prevention function

Efforts should be made to enhance the urban disaster prevention functions of rivers, including their roles as sources of water for firefighting in times of disaster and domestic water for post-disaster use and as fire breaks, refuge shelters, evacuation routes, and emergency mass transport routes.

2. Space supporting urban activities

In rivers and riverside areas, appropriate utilization of river spaces to enable diverse urban activities to be conducted while at the same time maintaining an appropriate balance with preservation of the natural environment should be promoted.

In areas with concentrated population and assets, the promotion of city planning in combination with the construction of flood- and earthquake-resistant embankments of a high standard that facilitate access to the river and the securing of high scenic value should be considered.

Utilization of river transport should be promoted to mitigate urban land traffic and reduce environmental burdens such as greenhouse gas emissions. Also, construction and improvement of nodal points connecting to land traffic should be implemented.

Chapter 6 Monitoring

Section 1 General Information

For appropriate management of water and sediment, etc., investigation, planning, construction, and maintenance processes need to be perceived as a series of processes in an integrated system, and it is important to monitor and assess each process as it is implemented so that the results can be reflected in each process for reexamination and improvement.

Since natural and social conditions keep changing in the basin, including in the river itself, it is important that monitoring, assessment, and feedback are always properly implemented. This chapter describes the basic concept of monitoring.

Explanation

Bed configurations, flow volume, and the environment of a river are closely related to and change with the natural and social conditions in the basin. For this reason, a mechanism that allows the communities in the basin, including in the communities in the river itself, to be kept in optimum condition should be established through the monitoring of water, sediment, land and space, and facilities for the purpose of appropriate assessment of the current situation. From these results, the mechanism should enable feedback to planning, construction, and maintenance whenever necessary.

Moreover, since this goal cannot be attained through the sole efforts of river, sediment management, and seacoast administrators and corporations, it is important to enhance cooperation with the organizations, bodies, parties, and persons concerned with the basin to grasp changes in the natural and social conditions in the basin and to collaborate with these parties to implement various projects.

This chapter is based on the above-mentioned concepts and is divided into sections on monitoring of water and sediment, land and space, the river environment, and facilities, each describing the basic concept of monitoring necessary for the target element. Monitoring of these elements needs to take into account the relationship between the entire water cycle system and the entire sedimentary system, and it is necessary to allow coordination between these systems.

Section 2 Monitoring of Water, Sediment, etc.

2.1 Monitoring associated with flood control

2.2.1 Overview

Monitoring associated with flood control means comprehensive monitoring of precipitation, water flow, and sediment volumes of the river and is conducted to enable appropriate planning, construction, and maintenance processes as a series of processes in an integrated system. The prevailing situation of flood control should be assessed from monitoring results and feedback should be given to planning, construction, and maintenance processes as appropriate.

Explanation

To grasp the current status of the measures developed and implemented from “River Planning” in Chapter 2, “Erosion and Sediment management Planning (Countermeasures for Sediment Disasters, etc.)” in Chapter 3, and “Seacoast Preservation Planning” in Chapter 4, it is important to appropriately monitor hydrologic and hydraulic information such as precipitation, flow volumes, wind, waves, and sediment-related information such changes in sediment load, the river bed, and the shoreline, and to assess their current status on the based of information obtained through monitoring.

The results of the monitoring should be used to judge whether the above measures based on flood control plans are taking effect as expected or not; if they are not, then the monitoring results are used to determine whether the conditions in the basin or river have changed or whether appropriate maintenance has been implemented. From these judgments, necessary feedback should be given to the planning, construction, or maintenance processes.

In monitoring related to flood-control, water and sediment phenomena are interrelated with plans for flood prevention, sediment disaster prevention, and coastal protection. Therefore, appropriate coordination between monitoring and these plans is necessary.

2.2.2 Water flow volume monitoring

Water flow volume monitoring means the monitoring of precipitation at predetermined locations and of water levels, tide levels, and flow velocities (flow rate), etc. at the time of flooding; this information contributes to the prediction of flooding, the provision of flood information, and the operation of facilities. From the results of monitoring, the runoff rate, channel roughness, etc. should be assessed, and feedback should be given to the basic items associated with flood prevention and those associated with coastal protection, as required.

Explanation

The target phenomena here are mainly floods and storm surges. The monitoring methods to be employed should be those described in the Manual for Hydrological Observation and in the Research Volume of the Technical Criteria for River Works (Draft).

The items to be monitored first when a flood has occurred or is likely to occur include the rainfall in the river basin, the water surface elevation and flow velocity (flow rate), and the tide level at predetermined locations of the river. The results of monitoring should be used for the operation of river management facilities such as dams and weirs; the preparation of flood forecasts and flood fighting warnings; and the provision of flood forecasts to the communities in the basin.

Locations for monitoring should be determined in advance based on the natural and social conditions in the basin; usually, the locations determined in the flood prevention plan or flood fighting plan should be used. Depending on the predicted scale of the flood and the status of the flood control facilities, flood prediction may be necessary; therefore, it is necessary to note that, in some cases, it will be appropriate to set additional target locations.

The results of monitoring are used to evaluate the relationships between rainfall amount and runoff volume and water level and discharge rate. If a flood water level is found to be significantly high or low compared with past floods of comparable size, then other factors, such as the relationship between water level and channel roughness, should be investigated. If necessary, the essential elements of flood control (design scale, facility arrangement, etc.) should be reexamined and the results reflected in the maintenance of trees in the river channel and river, improvement and preservation of the river environment, erosion and sediment management planning (countermeasures for sediment disasters, etc.), and basic items associated with coastal protection.

It is also important to assess the attributes being monitored and locations from the results of monitoring.

Monitoring methods such as the use of rainfall radar should be upgraded at appropriate times in response to advances in technological development.

2.2.3 Sediment monitoring

Sediment monitoring means measurement of the longitudinal profile and cross sections of the river, shape of the shoreline of sea coasts, and, if necessary, river bed materials and the sediment transport rate, etc. Measurements are made at pre-determined locations periodically and after the occurrence of abnormal phenomena such as floods and storm surges. This monitoring helps to provide flood information and in flood prediction.

The results of monitoring should be used to assess sediment movement and riverbed deformation and then fed back to review the major elements of flood prevention, and coastal protection, or erosion and sediment management planning (countermeasures for sediment disasters, etc.) as required.

Explanation

The items that need to be monitored during a flood or when a flood is likely include sediment movement and water volume. Monitoring should cover the entire sediment system, including the sediment yield area, sediment movement in torrents, riverbed deformation, suspended sediments, and bed load sediments.

Sediment monitoring is important not only for erosion and sediment management planning (countermeasures for sediment disasters, etc.) but also for providing feedback to river planning and seacoast preservation planning. Since the water surface elevation at the time of an actual flood cannot be predicted without knowledge of sediment movement during the flood, it is necessary to track riverbed deformation to determine the adequacy of the river planning and, especially, the water level at the design flood discharge.

2.2.4 Inner water monitoring

Inner water monitoring means monitoring away from the main river channel at pre-determined locations. Items monitored include rainfall, the water levels of minor rivers and their receiving waters, and the working of drainage pumps, etc. Such monitoring contributes to the prediction of landside flooding, the provision of inner water information, and the appropriate operation of drainage facilities. From the results of monitoring, inner water treatment should be assessed, and feedback should be given to the inner water treatment plan and facility operation.

Explanation

Many inner water disasters are caused by the overtopping of runoff from medium-sized and small rivers, waterways or sewerage systems because their drainage capacity is exceeded or from rainfall exceeding the capacity or the design scale of the subject facilities. In a region with landside areas that are becoming progressively urbanized, in particular, reduced permeability and other factors are likely to increase the run-off coefficient, potentially leading to design drainage capacity being exceeded.

Sometimes the high water level of the receiving river makes it difficult for the feeder river to discharge excess water, even if the flow volume is within the normal drainage capacity of the feeder river. Therefore, it is important to assess drainage by monitoring the rainfall in the landside basin, the water levels of the landside river and the receiving river, and the working of drainage pumps.

The monitoring methods to be employed should be those described in the Manual for Hydrological Observation and in the Research volume of the Technical Criteria for River Works (Draft).

2.2 Monitoring of appropriate river utilization and maintenance of normal functions of river water

Monitoring of appropriate river utilization and maintenance of normal functions of river water means the monitoring of water volume, water quality, etc., to determine the degree to which normal flow volume is secured and the effectiveness judged. In accordance with the results of monitoring, the water quality, etc. should be assessed and feedback should be given to measures for appropriate river utilization and maintenance of the normal functions of river water, as appropriate.

In selecting locations for monitoring, the locations that were examined in the basic items associated with the maintenance of normal functions of river water should be included in the examination, and locations appropriate for monitoring should be selected.

Explanation

Monitoring of the water volume and quality should be conducted for the following purposes:

1. To grasp the degree to which normal flow volume is secured

Monitoring should be conducted to check whether the predicted normal flow volume occurs as planned.

2. To judge the effects of securing normal flow volume
Monitoring should be conducted to check whether the achievement of normal flow volume causes any problems.
3. To judge the effects of measures taken to secure normal flow volume

Monitoring should be conducted to determine whether the implementation of individual measures has been progressing as planned, the expected effects have been achieved, and the entire plan has produced the expected effects at representative locations.

From the results of the above monitoring, the basic items associated with the maintenance of normal functions of river water should be reviewed wherever necessary.

Important data for determining the normal flow volume can be obtained especially at the time of extraordinary drought; therefore, substantial monitoring of water volume and quality has to be conducted to determine:
1. How well the environmental standards in the subject public water body are met
2. The extent to which the water quality permits comfortable recreation in the subject river
3. The appropriateness of the water quality for water utilization
4. The appropriateness of the water depth, current velocity, and water quality for preserving healthy habitat for plants and animals
5. The extent to which the surface width and water quality (including freedom from litter) necessary for creating a good landscape are obtained.

In monitoring the water volume, locations representing the flow regime of the target water area should be selected from longitudinal characteristics such as the water balance (merging, branching, etc.) and water utilization, and the flow volumes of the main stream and tributaries should be determined.

The water balance of the river can be affected by changes in drainage discharge due to the construction or improvement of sewerage systems, changes in rivers as receivers of discharge due to the construction of bypasses, and changes in groundwater utilization, etc. Therefore, data and general information on the amount of drainage discharge, the amount of water intake, the groundwater level, the amount of groundwater extraction, etc. should be gathered as required.

In principle, the observation of water volume is based on continuous observations, such as conversion (discharge curves) of the values obtained from automatic observations of water level.

2.3 Monitoring of sediment

2.3.1 Overview

Monitoring of sediment needs to be conducted, because to implement comprehensive sediment managements and prevent disasters caused by the movement of sediment, etc., it is important to determine the volume and quality (grain size) of sediment from the viewpoint of spatial and temporal continuity and to predict their future changes.

Explanation

To prevent disasters associated with sediment movement, to preserve river and coastal habitats and landscapes, and to properly utilize the river or sea coast it is necessary to comprehensively and properly manage sediment movement and the resulting topographical changes over the entire sediment system. To this end, it is necessary to conduct sediment monitoring, since it is important to survey not only the amount of sediment movement in the entire sedimentary system but also the channel morphology and quality (grain size) as well as the current status of their temporal change. From these results, it is necessary to predict short-term and medium- to long-term future changes.

In this section, monitoring of sediment is divided into two categories: 1) monitoring of sediment yield and discharge in sediment yielding areas, and 2) monitoring of riverbed deformation and sediment transport in the sediment transport area. However, these divisions are inseparably interrelated and have to be in harmony with each other in space and time.

2.3.2 Monitoring in sediment yielding areas

The aim of monitoring in the sediment yielding areas is to determine the sediment yield and sediment runoff, etc. by measuring the erosion rates and amounts of deposition in torrents on hillside slopes, mountain-ringed areas, and alluvial cones, etc., and the sediment discharge in torrents, etc. In conducting monitoring, efforts should be made to identify the grain size distribution of the sediment.

Explanation

Sediment yield on a hillside slope occurs as a result of slope failures, landslides, erosion, and expansion of already collapsed areas. In torrents in mountain-ringed areas and alluvial cones, etc., sediment is produced as a result of riverbed and side erosion. Sediment yield should be determined from the erosion and deposition volumes obtained by measuring the amounts of topographical change of hillside slopes, torrents, etc.

The sediment runoff volume from a sediment yielding area can be determined by measuring the sediment deposits in erosion control dikes or directly measuring sediment concentration in runoff at the same time as river discharge is measured.

Topographic or sediment deposition surveys and observations should be conducted periodically or before and after a flood. Measurements of sediment runoff discharge should be conducted at the time of flood, with secured safety to determine the variation. The temporal variation in sediment yield and discharge in the sediment yielding area should be determined by conducting surveys and observations continuously from upstream to downstream.

2.3.3 Monitoring in a sediment transport area

The aim of monitoring in a sediment transport area is to determine the sediment movement rate by measuring

topographical changes in the middle and lower reaches of the river, the estuary, and the shoreline, as well as the sediment load of the river and the longshore sediment transport rate along coasts.
In the process of monitoring, efforts should be made to identify the grain size distribution (quality) of the material comprising riverbeds, beaches, etc.

Explanation

River channel erosion, sediment deposition, and changes in the shape of the shoreline occur as sediment moves in the sediment transport area. Topographic changes in the channel and the shape of the shoreline should be measured, and the sediment movement itself should also be measured by investigating the sediment transport rate both in the river and in the longshore sediment transport area.
Sediment transport monitoring should be conducted not only before and after a flood or storm surge but also periodically, so that the sediment transport during normal periods can be grasped. Temporal changes in sediment transport should be observed by continuous measurement.
Since riverbed variation itself is important when considering the safety of the river channel against floods within the design high water level or the effects of sediment movement on the river environment, not just the sediment movement, but also the riverbed variation itself, needs to be monitored.

Section 3 Monitoring of Land and Associated Space

3.1 Overview

Monitoring of land and space is aimed at comprehensively monitoring the landform, usage pattern, vegetation, etc. in river basins, seacoast preservation areas, erosion and sediment management project areas, etc. to prevent and mitigate disasters, achieve appropriate use of space, and improve and preserve the environment. Assessments should be made from the results of monitoring, and each plan and maintenance program should be reviewed as required.

Explanation

For the measures implemented in accordance with “River Planning”, “Erosion and Sediment management Planning (Countermeasures for Sediment Disasters, etc.)”, and “Seacoast Preservation Planning” (described in Chapters 2 through 4) to remain effective, it is essential to properly manage the land and space of rivers, erosion and sediment management areas, and seacoasts.
“Land and space” here includes ground surface, underground areas, water surfaces, and airspace in an area designated by law. The longitudinal and transverse forms of the river, including its low flow channels, water surface, use of high water channels, vegetation in high water channels, soil cover condition, etc. should be monitored through measurements such as surveys. In addition, the approval of permits for area occupancy needs to be included in these considerations.
The results of monitoring, together with the results of water and sediment monitoring, should be evaluated from various viewpoints, such as disaster prevention and mitigation, appropriate use of space, and improvement and

preservation of the environment. If it is determined that the expected effects have not been obtained, then feedback should be given to each plan, construction, and maintenance program.

3.2 Monitoring for flood control

Land and space monitoring for flood control means the comprehensive monitoring of the river channel and beach profile, etc. through longitudinal and transverse surveys and vegetation distribution investigations in order to manage land and space for the prevention and mitigation of disasters caused by floods and storm surges. The results of monitoring should be used to assess flood containment capacity etc. and, if necessary, to review the basic elements of flood prevention, coastal protection, and erosion and sediment management plans (countermeasures for sediment disasters, etc.), and the maintenance of these.

Explanation

Land and space monitoring for the prevention and mitigation of flood disasters should be conducted for longitudinal and transverse river channel management to secure an appropriate level of flood containment capacity. It especially aims to manage the bed slope, plain figure, flow section, and roughness. In monitoring, attention should be paid to changes in temporal and spatial conditions.

Flood and sediment runoff characteristics vary depending on the land use and vegetation in the river basin, the installation of structures, and the vegetation distribution in the river channel, etc. For this reason, to allow a flood within the design high water to flow safely, it is important to assess the flood-carrying capacity by means of longitudinal and transverse surveys of the river channel, vegetation surveys, discharge observations during an actual flood, etc. The trend in temporal variation and riverbed deformation during a flood also needs to be taken into account. If it is determined that the expected discharge capacity is not satisfied, then section excavation, dredging, cutting of vegetation, and installation of river structures such as spur dikes should be executed. If necessary, the essential elements of flood prevention and erosion and sediment management plans (countermeasures for sediment disasters, etc.) should be reviwed.

On the other hand, the targets of land and space monitoring for erosion and sediment management planning (countermeasures for sediment disasters, etc.) include hillsides and torrents, which are sediment yielding areas, and sediment transport areas, etc. The longitudinal and transverse forms of the river, slope conditions, etc. should be monitored and assessed. The concept of monitoring here is the same as for land and space management, aiming to prevent and mitigate flood disasters as described above.

Land and space monitoring for the prevention and mitigation of storm surge disasters targets seacoasts and estuaries, and it should be conducted in the same way as for the aforementioned land and space management to prevent and mitigate flood disasters. For coastal monitoring, the main targets of monitoring are the sandy beach and beach profile; permit approval should be obtained for occupied areas.

3.3 Monitoring associated with utilization

Land and space monitoring for utilization aims to monitor the statuses of land occupancy and utilization in order to optimize river and seacoast utilization and secure healthy habitat for animals and plants. Assessment should be carried out from the results of such monitoring, and if necessary, plans related to the fundamentals of maintenance, improvement and preservation of river environments should be reviewed.

Explanation

River areas and spaces consisting of water surfaces, high water channels, etc. and coastal land and spaces consisting of seawater surfaces, sandy beaches, etc. are valuable spaces for fostering diverse ecosystems and creating therapeutic landscapes. Combined with the surrounding nature and streets, they also form valuable landscapes. In addition, they are public spaces for utilization by community members living in the basin and coastal areas and are spaces that can be used as emergency evacuation sites and recovery bases in times of earthquake disaster.

In the utilization of land and spaces along rivers and seacoasts, in principle, utilization for public purposes should be given priority while considering the fact that they serve as habitat for animals and plants. And, since fairness is important in the utilization of the limited land and spaces to avoid conflict in use, comprehensive monitoring should be conducted for permit granting for land and space occupancy. Investigations are also necessary for the use of water surfaces, high water channels, and sandy beaches, etc.

The results of such monitoring should be evaluated from the viewpoints of transparency, fairness, and orderly utilization as well for the effects on environmental improvement and preservation. If it is determined that the land and spaces are, in general, not properly being used, then use zoning should be reexamined and permissions for land and space occupancy and their maintenance should be reviewed.

Moreover, it is desirable to simultaneously implement projects for improvement of access to the river or seacoast by installing gently sloping dikes, etc. and by tree planting and installation of public lavatories, as well as by implementing other improvement measures that will promote utilization, such as the installation of signs.

Section 4 Monitoring of the Environment

Monitoring of the environment means monitoring of river and seacoast shapes, ecosystems, landscapes, water quality, etc. The results of monitoring should be evaluated and used to review the items associated with river environment improvement and preservation, coastal environment improvement and preservation, and erosion and sediment management planning (countermeasures for sediment disasters, etc.).

Explanation

Monitoring of the environment should be conducted to monitor the river morphology (including riffles and pools), habitat for animals and plants, landscapes, locations used for river-based human activity, (such as walkable embankments), and water quality. Such monitoring should aim to:

1. Determine the level of goal achievement

Monitoring should be conducted to check whether the goals for improvement and preservation of the environment that were set at the time of plan establishment have been achieved as expected.

2. Determine the beneficial and adverse effects and impacts of goal achievement

Even if the goals set for improvement and preservation of the environment have been achieved, the uncertainties that surround river and coastal environments necessitate that monitoring should be conducted to check whether the expected effects have been obtained, whether unpredicted impacts are noticeable, and whether issues identified at goal setting have been resolved. If the results of monitoring show any deviation from expectations, it is important to analyze the cause.

3. Determine the effectiveness of measures

Monitoring should be carried out to judge whether the measures for improvement and preservation of the environment were most appropriate for achieving the goals that were set.

4. Feed back the results to goal setting and measure establishment

The results of environmental monitoring should be fed back into the goals for improvement and preservation of the environment and the establishment of measures.

Preliminary surveys are necessary to determine and evaluate the effects and impacts. During this process, it is important to grasp the status of not only the river, but also its basin.

Substantial monitoring should be conducted during abnormal drought or periods of abnormal water quality or after floods. Such monitoring provides important data and information for use in considerations for improvement and preservation of the river environment, etc.

It is important that the results obtained from such monitoring be used effectively for maintenance.

Section 5 Facility Monitoring

5.1 Monitoring associated with the assessment of facility planning

Monitoring associated with the assessment of facility planning means comprehensive monitoring to check whether the expected functions of the facilities and measures implemented as a result of river planning, erosion and sediment management planning (countermeasures for sediment disasters, etc.), and seacoast preservation planning are being achieved despite changes in the natural and social conditions that have taken place after their installation. The results of monitoring should be assessed and used to review facility plans and revise them as required.

Explanation

Facilities for river management, erosion control, and seacoast preservation and related structures are planned and constructed in accordance with River Planning (Chapter 2), Erosion and Sediment management Planning (Countermeasures for Sediment Disasters, etc.) (Chapter 3), and Seacoast Preservation Planning (Chapter 4). The question of whether the expected functions of these facilities and structures have actually been fulfilled is more important than their existence. There will be cases in which the arranged facilities are not fulfilling their expected functions due to changes that have taken place in the natural and social conditions of the river basin or in the river and coastal characteristics after construction of the facilities.

For this reason, monitoring and assessment should be carried out through the implementation of monitoring as described in Sections 1 through 4 of this chapter to check whether the arranged facilities, etc. are fulfilling their expected functions, and facility planning should be reviewed and revised as required. Relevant examples include re-examination of the intake rate due to reduction in the amount of agricultural land, reconstruction of intake facilities due to degradation of the riverbed, and beach nourishment in response to coastal erosion. Functional degradation of facilities due to deterioration, etc. will be referred to in Section 5.2 below.

5.2 Monitoring associated with functional maintenance

Monitoring associated with functional maintenance means comprehensive monitoring to check whether the facilities, etc. arranged in accordance with river planning, erosion and sediment management planning (countermeasures for sediment disasters, etc.), and seacoast preservation planning are fulfilling their expected functions. The results of monitoring should be assessed and fed back into facility plans as required.

Explanation

River management facilities such as river dikes and groundsills and seacoast preservation facilities such as coastal dikes and beach nourishment facilities must possess the functions that are stipulated in the Cabinet Order Concerning Structural Standards for River Management Facilities, etc. and the Criteria for Seacoast Preservation Facility Construction, etc., and it is important for the management of rivers, etc. that these functions are continuously maintained without deterioration.

The planning and design of plans for the management of water, sediment, etc. and arrangement of facilities should be carried out in such a way that the functions expected of the facilities can be fulfilled in consideration of the level of maintenance. It is important to conduct thorough monitoring through surveys and measuring instruments and, from the monitoring results, to assess the functionality of the facilities to check whether the facilities are fulfilling their expected functions.

The items, timing, and frequency of monitoring should be dependent on the purpose and expected functions of each facility. In general, though, monitoring should be conducted through periodic inspections, inspections at the times of floods and storm surges, and inspections after such events. Measurements that require specialized measuring equipment should be conducted more efficiently if such considerations are included in the design and construction of the facilities.

It is important that the results of monitoring be organized using predetermined formats for the assessment of facility functionality. If it is determined that the functions of the facility have deteriorated and are not satisfying the expected standard, the results should be fed back into the facility plan (which may lead to reconstruction) or maintenance so that proper functions of the facility should be achieved.

Reference

1) Hydrological Observation, 2002 Edition, Authored and edited by the Public Works Research Institute, Supervised by the River Bureau of the Japanese Ministry of Land, Infrastructure and Transport. Published by the Japan Construction Engineers' Association