

SECTOR K

WATERSHED MANAGEMENT

VOLUME 3: SUPPORTING REPORT
SECTOR K: WATERSHED MANAGEMENT

TABLE OF CONTENTS

1.	Basic Concept of Watershed Management.....	K-1
2.	Watershed Management in Lai Nullah Basin	K-1
2.1	Major Issues on Watershed Management in Lai Nullah Basin	K-1
2.2	Necessity of Watershed Management in Lai Nullah Basin	K-2
2.2.1	Activities on Watershed Management so far Undertaken	K-2
2.2.2	Consideration of the Watershed Management in Lai Nullah Basin	K-6
3.	Introduction of Watershed Management in the Other Basin	K-8
3.1	Outline of the Tsurumi River	K-8
3.2	Major Issues on Watershed Management in Tsurumi River Basin	K-8
3.2.1	Flood	K-8
3.2.2	Low Water	K-9
3.2.3	Environment.....	K-10
3.3	Activities for Watershed Management in Tsurumi River Basin.....	K-11
3.3.1	Outline of the Tsurumi River Basin Management Master Plan	K-11
3.3.2	Basic Strategy of Watershed Management.....	K-12
4.	Recommendation	K-15
4.1	Comparison of Watershed Management Activities in both River Basins	K-15
4.2	Recommendation.....	K-15

Figures

LIST OF TABLES IN REPORT

Table R K.1	The Number of Check Dams and Groundsills	K-3
Table R K.2	Activities of Watershed Management	K-4
Table R K.3	Effectiveness	K-5
Table R K.4	Activities of Watershed Management	K-5

LIST OF FIGURES IN REPORT

Fig. R K.1	Location of Measures for Watershed Management in Rawal Dam Basin.....	K-4
Fig. R K.2	Change of Run-off Condition by Land Development	K-9
Fig. R K.3	Change of Volume of Flow at Normal Times	K-10

LIST OF FIGURES AT THE BACK OF REPORT

Fig. K.1	Effectiveness of Waterashed Management.....	F-K-1
----------	---	-------

SECTOR K WATERSHED MANAGEMENT

1. BASIC CONCEPT OF WATERSHED MANAGEMENT

In general, the term “watershed management” is used for any activity concerning water management in a river basin such as water resources management, flood mitigation and environmental preservation. In natural river basin condition without any human interaction, water quantity and quality are well preserved, in general, so that river water can be used even for drinking without any treatment.

For such a river basin, any human activity is a menace to the preservation of water quality and quantity, especially on-land developments, such as agricultural development, deforestation and urbanization, which result in deterioration of water quality and change of flow regime, i.e., increase of flood discharge and decrease of low water discharge.

The measures for watershed management include all measures for the protection, management and preservation of water resources and their related land resources. As the typical measures for protection of land development, the following items are envisaged: (1) land use control and monitoring, (2) restoration work on disorderly development such as deforestation; and, (3) land erosion control.

2. WATERSHED MANAGEMENT IN LAI NULLAH BASIN

2.1 Major Issues on Watershed Management in Lai Nullah Basin

In the Lai Nullah basin, land development associated with the exploitation of water sources in the whole basin has been going on for quite a long time. As the results of such activity, the following issues are pointed out, although specific data to identify such the conditions are very limited:

- (1) Water quality has been deteriorating;
- (2) Water conservation capacity of forest has been decreasing;
- (3) Sediment production has been increasing;
- (4) The volume of flood discharge with peak discharge as well as flood damage, has been increasing, while that of low water discharge has been decreasing;
- (5) Grand water level has been lowering, and;
- (6) Others.

In the context of the Study on flood mitigation and environmental improvement, all of these issues, in principle, are necessary to be considered.

2.2 Necessity of Watershed Management in Lai Nullah Basin

As can be noted from the above conditions, it is necessary to practice watershed management in the Lai Nullah basin to mitigate the above major issues. To successfully practice watershed management, the causes that brought these conditions should be reduced.

One of the main causes of appearance of the above conditions is continuous land development all over the basin as aforementioned. In general, land development is inevitable in accordance with the population growth as well as development of commercial and industrial activities. In this connection, if such land development is promoted disorderly neglecting the aspects of watershed management, the influence to the above issues will further expand. Thus, it is crucial to consider the aspect of watershed management to minimize the impact of land development.

Among the main points to consider in planning a favorable land development program seems to be coordination and collaboration among the stakeholders related to the land development as well as water and environment management. The nomination of a responsible agency, which will handle basin-wide watershed management is also one of the main points for consideration.

2.2.1 Activities on Watershed Management so far Undertaken

The necessity of watershed management may have already been discussed among the agencies concerned and management has already been practiced by several agencies. As examples of watershed management in the Lai Nullah basin including neighboring areas, the following activities are pointed out:

1) Watershed Management of Rawal Dam

According to PC-1 for watershed management of Rawal Dam prepared by the Small Dams Organization in 1995, the outline of the project is as follows:

a) Project Background

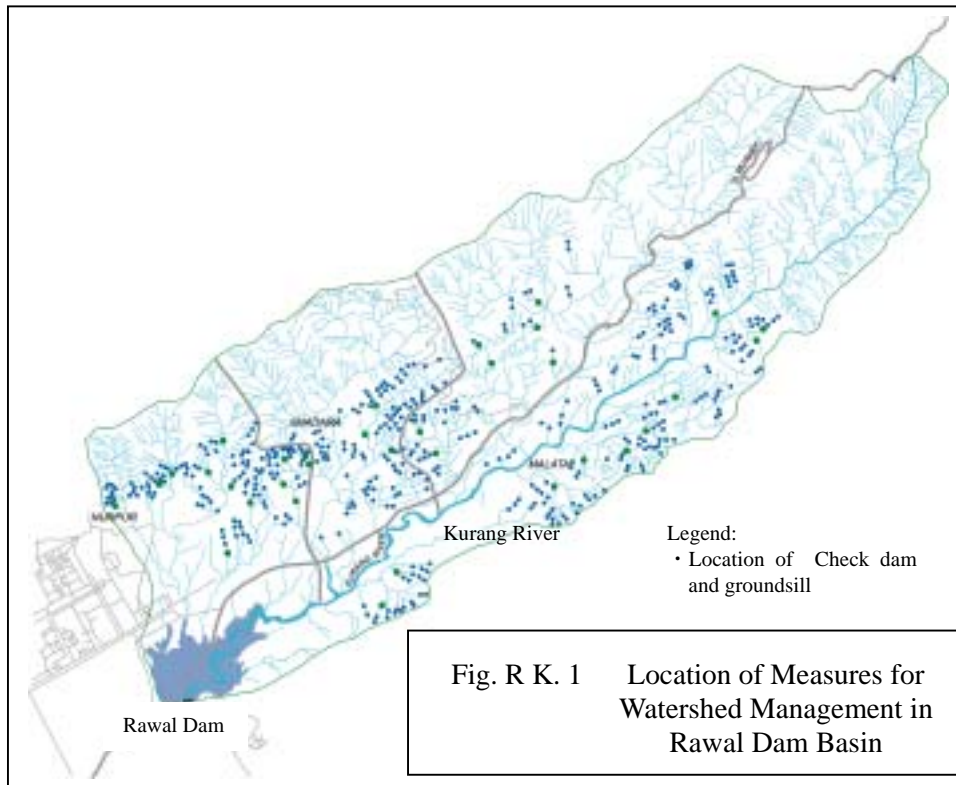
Rawal Dam was constructed in 1960 to supply domestic water for Rawalpindi across Kurang River. However the storage capacity of the dam has been reduced due to the silt coming from upstream of the Dam. The hydrology surveys conducted to assess the economic life of the Dam in 1966, 1969, 1972, 1975, 1984 and 1991, show that the current gross capacity of the Dam has decreased in volume from 58.5 million m³ to 39.0 million m³ in 31 years, resulting in the 79% reduction of dead storage capacity. Thus, the consciousness on watershed management has been aroused.

b) Outline of the Project

In this project, the tributaries areas such as Noorpur, Shahdara and Kurang have mainly been taken up in checking sediment transport from upstream into the Rawal dam. For the purpose, a number of check dams and groundsills have been provided as given in the following table:

Table R K. 1 The Number of Check Dams and Groundsills

Name of Tributaries	No. of Check Dam	No. of Groundsill
Main Kurang	100	9
Small Kurang	60	4
Shahdara	125	3
Noorpur	70	9
Total	355	25



2) Watershed Management of Lai Nullah

In the Lai Nullah basin, watershed management activities have been undertaken by CDA with the construction of check dam and afforestation in the upstream, and also land use control along the river course. Afforestation has been practiced since 1960's and the recent plantation volume has been about 200,000 trees (the area of about 200

ha/year). Unfortunately, the data showing the details of the check dam are not available.

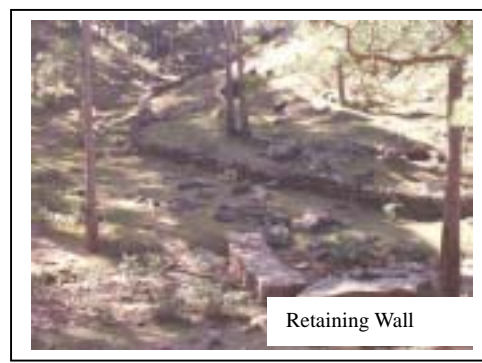
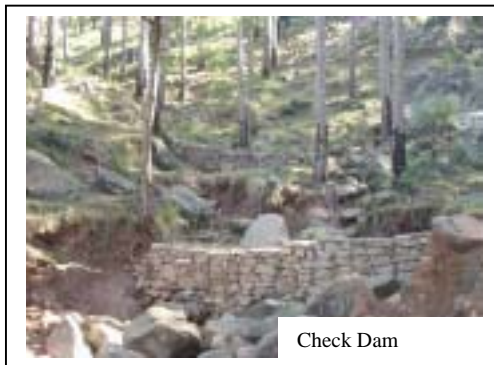
3) Watershed Management of Simly Dam

a) Watershed Management Activities for Simly DAM

The Simly dam, the third highest dam in Pakistan after Tarbela and Mangla, was constructed in 1982 to supply domestic water for Islamabad. This dam also has siltation problem due to silt coming from the upstream. To cope with the problem, CDA has been exercising watershed management in the river basin upstream of the Simly Dam in a manner of construction of check dam, terracing retaining wall, silt detention dam and afforestation. The number of these measures is as shown in the following table and photograph:

Table R K. 2 Activities of Watershed Management

Financial Year	Afforestation		Check Dam	Silt Detention Dam
	Nos. (thousand trees)	Acres		
82/83 – 94/95	2,123	3,787	18,598	24
95/96 – 97/98	829	1,685	4,813	32
98 – 99	130	150	450	-
99 – 00	376	230	697	-
00 – 01	127	145	378	-
Total	3,588	5,997	24,928	56
Average (/year)	179	300	1,200	-



b) Effectiveness of Watershed Management Activities

The effectiveness of watershed management activities has been evaluated through monitoring of sedimentation in the Simly dam reservoir.

After the construction of Simly dam, the monitoring of sedimentation in the Simly dam reservoir had been conducted two times: 1994 and 1999. For the first monitoring in 1994, the sediment deposit volume was calculated to be 4,071 thousand m³ for 11 years, which corresponds to that of 370 m³/year. Then, for the second monitoring in 1999, the sediment deposit volume was calculated to be 967 thousand m³ for 5 years, which corresponds to that of 193 m³/year. Thus, the annual sediment deposit volume has been remarkably reduced from 370 m³/year to 193 m³/year in accordance with the work volume of watershed management activities.

The relation between the watershed management activities and total sediment deposit volume is shown in the following table and Fig. K.1

Table R K. 3 Effectiveness

Sr. No.	Period	Duration (year)	Total Sediment Deposit (Acre feet/thousand m ³)	Average/year (Acre feet/thousand m ³)
1	83 – 94	11	3,354 (4,071)	305 (370)
2	94 – 99	5	797 (967)	159 (193)
	83 – 99	16	4151(5,038)	259 (314)

The activities so far conducted are summarized in the following table.

Table R K. 4 Activities of Watershed Management

Project	Implementation Agency	Location	Major contents of the Project
Watershed Management of Rawal Dam*	Small Dams Organization	Catchment area of Rawal dam (Out of Lai Nullah)	355 check structures and 25 Nos. bed bars (The works were completed at the end of 2002 October.)
Watershed Management of Lai Nullah	CDA	CDA Territory in Lai Nullah basin	Construction of check dam, landscaping, and afforestation**, land use control in the upstream and along the river course
Watershed Management of Simly dam***	CDA	Catchment area of Simly dam (Out of Lai Nullah)	Construction of check dam, terracing, retaining wall, silt detention dam afforestation,

*: Source: PC1 for watershed management of Rawal Dam

** : Afforestation has been practiced since 1960's. Recent work volume is plantation of about 200,000 trees (the area of about 200 ha/year). (Source: Environment, CDA)

***: As the effectiveness of the watershed management, annual sedimentation volume remarkably reduced as follows: from 0.37 million m³/year ('83 – '94) to 0.19 million m³/year. (Source: Simly Dam Project, CDA)

Sector K

In case of Lai Nullah Basin, CDA has undertaken several works in the territory, as shown in the above table. On the other hand, in Rawalpindi and the Cantonment area, no concrete action regarding watershed management has so far been undertaken. Furthermore, at present, there may not be an agency responsible for basin-wide watershed management. Thus, judging from the present water issues as above-mentioned, it seems to be necessary to strengthen watershed management currently being practiced. As the major reasons for not undertaking watershed management could be on or all of the following:

- (a) The necessity of basin-wide watershed management may not be highly recognized and understood among the agencies concerned and the inhabitants of the basin.
- (b) The agency responsible for basin-wide watershed management and coordination among agencies concerned may not be clear; and
- (c) There is no law that specifies the responsibility of agencies concerned in watershed management.

2.2.2 Consideration of the Watershed Management in Lai Nullah Basin

1) Watershed Management for Flood Problems

As far as the flood problems are concerned, the following conditions relating to watershed management are pointed out:

- (a) Increase of Flood Discharge;
- (b) Decrease of River Channel Flow Capacity; and
- (c) Increase of Flood Damage.

The watershed management for alleviation of flood problems is considered as follows:

a) Alleviation of Increase of Flood Discharge

As one of the main causes of increase of flood peak discharge, the land development in a manner of deforestation in the upper reaches and urbanization in the middle and lower reaches are pointed out. In principle, the following measures and activities are considered to cope with the situation:

- (i) Restriction of deforestation and implementation of afforestation in the upper reaches; and
- (ii) Land use control and introduction of detention facilities to compensate the increase of flood discharge due to land development in the middle and lower reaches.

b) Alleviation of Decrease of River Channel Flow Capacity

As the main causes of alleviation of decrease of river channel flow capacity, the followings are pointed out: encroachment on the river channel in a manner of construction of houses, buildings, etc., and dumping of garbage. (These issues are rather related to river management than watershed management.) As for the measures to cope with the situation, control and removal of encroachment and control of garbage dumping into the river are envisaged.

c) Alleviation of Flood Damage

Due to a combination of increase of flood peak discharge and decrease of river channel capacity, the flood damage naturally increases. Besides, land development in flood prone areas and encroachment to the river channel also result in the increase of flood damage. To alleviate these situations, land use control and removal of encroachment are pointed out.

2) Watershed Management for Other Water Issues

As the remaining major water issues, water resources development and utilization as well as the environment, are pointed out. Needless to say, to identify the detailed issues and measures to cope with the issues, further studies including arrangement of the necessary data are required, since such undertakings are too wide in scope to be covered under the present Study.

Under the above circumstances, only basic process for the further study on watershed management are described as follows:

- (a) The necessity of basin-wide watershed management on water resources development and utilization and environment should be highly recognized among the agencies concerned as well as inhabitants considering the current conditions relating to water utilization.
- (b) Agencies responsible for the watershed management should be confirmed.
- (c) The major water issues on water resources development and utilization and environment in Lai Nullah basin should be identified through arrangement and monitoring of necessary data to indicate the issues.
- (d) Necessary measures to cope with the major water issues should be analyzed and examined.
- (e) The watershed management plan to implement the necessary measures should be formulated. As the typical urgent issues, lowering of ground water level and

deterioration of water quality in Lai Nullah should be examined and actions should be taken to settle down the issues in a manner of watershed management.

3. INTRODUCTION OF WATERSHED MANAGEMENT IN THE OTHER BASIN

Herein, the practice of the watershed management in the other basin is discussed to facilitate future development of watershed management in Lai Nullah. As the example, the Tsurumi river in Japan which has similar characteristics as the Lai Nullah is introduced hereunder:

3.1 Outline of the Tsurumi River

The Tsurumi River, which has a catchment area of 235 km² and a length of about 42 km, flows through the urban area of western Metropolitan area. The upper reaches is dominated by hilly land with the altitude of 80m to 170m above mean sea level covering about 70% of the total area. The downstream reaches is flat land accounting for the remaining 30%. The river basin has been developing as the residential and industrial areas since the 1970's due to geographical advantage; namely, it is adjacent to Tokyo, the capital of Japan. The urban area has occupied about 85% of the whole basin as of the year 2000, which is compared to only 10% in 1958.

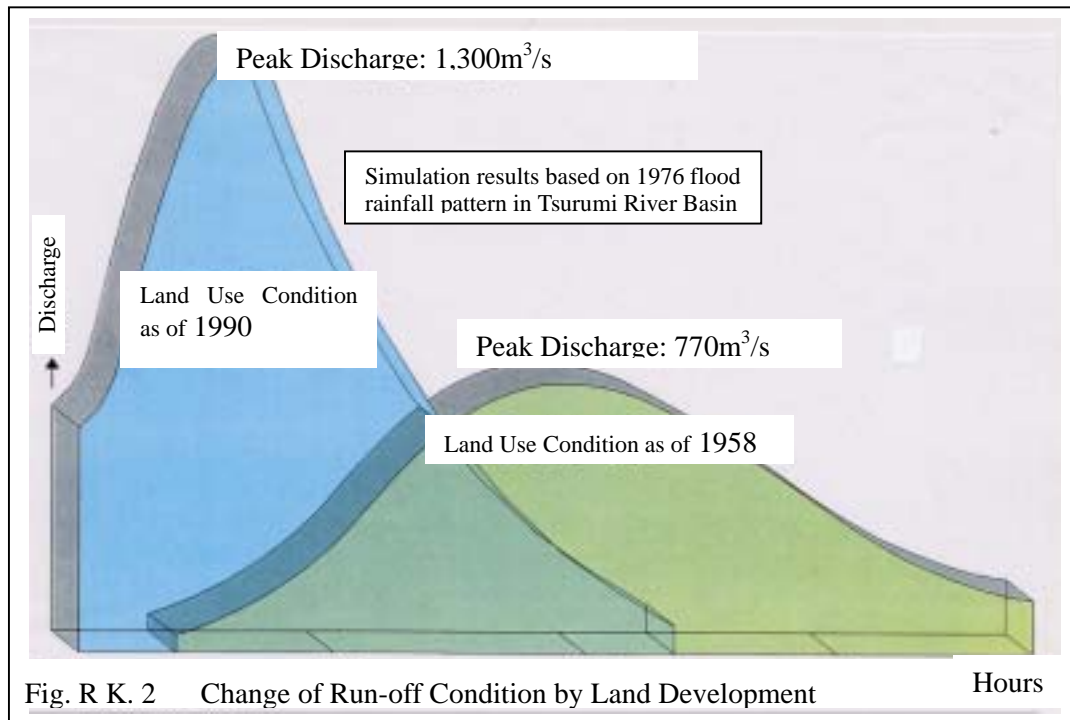
3.2 Major Issues on Watershed Management in Tsurumi River Basin

Due to the rapid urbanization since 1970's, the Tsurumi River Basin has a variety of issues on watershed management as presented below.

3.2.1 Flood

Flood is one of the serious issues in the Tsurumi River Basin. In spite of the efforts by stakeholders to cope with the flood issue, it has been deteriorating due to rapid urbanization.

The deterioration of flood issues is emphasized with the following conditions: increase of flood discharge and shortening of flood concentration time. According to the flood simulation results applying the same rainfall pattern to two types of land use, the flood peak discharge becomes almost double, while the flood concentration time shortens from 10 to two (2) hours.



3.2.2 Low Water

On the other hand, the land development has caused reduction of the low water discharge in the following manner:

- (1) Reduction of water infiltration capacity of the ground by pavement of road and through construction of housing.
- (2) Lowering of ground water level from the same reason mentioned above.
- (3) Reduction of discharge flowing into drainage channel by provision of sewerage channel.

Such condition is presented in the following figure:

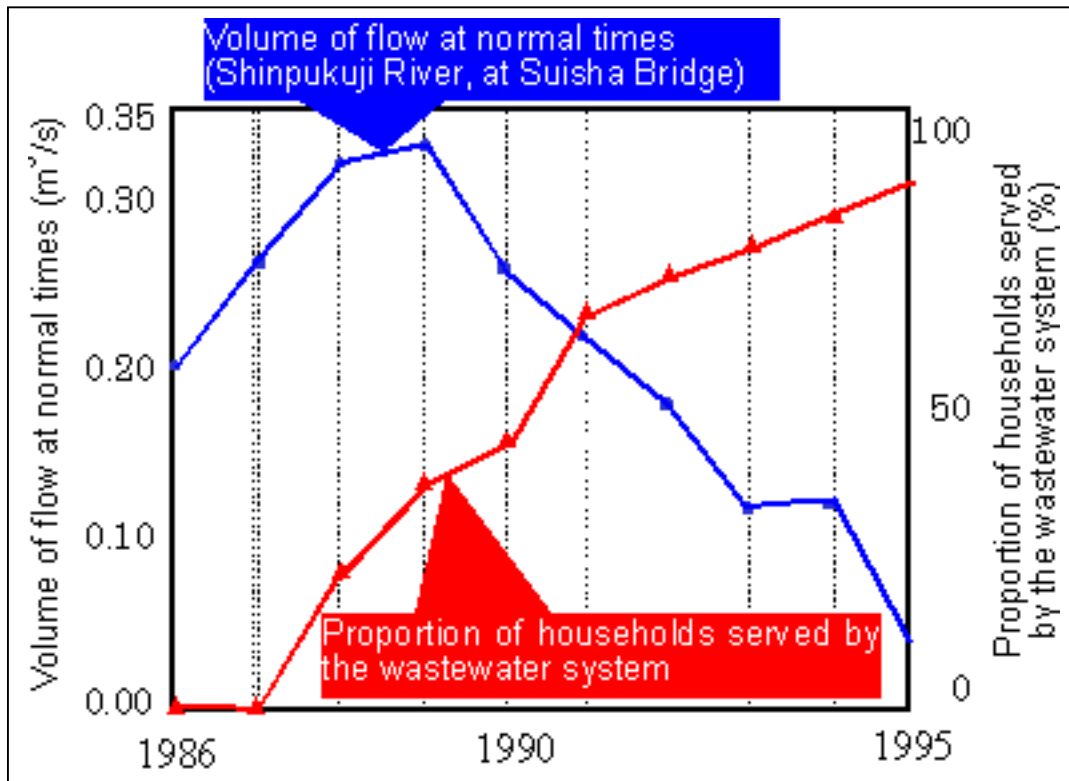


Fig. R K. 3 Change of Volume of Flow at Normal Times

As can be seen from the figure, the low water discharge at normal time has been decreasing from the end of 1980's in inverse proportion of increase of households served by the wastewater system.

3.2.3 Environment

As the environmental issues in the Tsurumi River Basin, the following matters are pointed out:

- (1) As the results of disorderly land development, green tracts of land have remarkably decreased and are scattered disorderly in the basin.
- (2) Due to concrete lining of the drainage channel and river channel, the natural ecology has been destroyed resulting in extinction of aquatic living things.
- (3) Abandoned unused land and paddy field has been increasing due to decrease of population engaged in agriculture.
- (4) The river channel does not function as amenity due to the inappropriate river channel improvement considering only the function of the route for water passage.

3.3 Activities for Watershed Management in Tsurumi River Basin

To cope with the several issues relating to the watershed management, stakeholders have decided to formulate “the Tsurumi River Basin Management Master Plan”. For formulation of the Master Plan, the Tsurumi River Basin Preliminary Committee was first established in 1999 with participation from stakeholders including local communities, and a proposal to formulate the Basin Management Master Plan was compiled in 2001 after a series of meetings and discussions on the matter. The formulation of the Basin Management Master Plan was entrusted to the Tsurumi River Basin Committee newly established in 2002 and the formulation work is on going with a series of meetings conducted by the Committee.

According to the proposal prepared by Preliminary Committee, the outline including basic strategy for the formulation of the Basin Management Master Plan is as presented below:

3.3.1 Outline of the Tsurumi River Basin Management Master Plan

1) Basic Concept

The “Basic Concept” of the master plan shows the provision of a preferable river basin considering hydrological cycle and the direction toward realization of such river basin.

2) Basin Water Management

a) Contents of Basin Water Management

The “Basin Water Management” shall cover the water issues on five (5) sectors; namely, (1) flood, (2) low water, (3) natural environment, (4) disaster such as earthquake and fire, and (5) amenity

Then, for each sector, the following items shall be discussed: basic strategy, target, development of applied measures in medium and long term, and basin plan.

b) Items to be discussed

i) Basic Strategy

In accordance with the basic concept, the basic strategy for water management shall be provided considering the current issues on each sector.

ii) Target

In the context of the basic strategy, the concrete target to achieve the water management shall be set.

iii) Development of Applied Measures

To cope with the water issues, the applied measures will be developed in the manner of mid- and long-term scheme.

iv) Basin Plan

The basin plan shall be prepared to show the future basin development features to be achieved in accordance with the strategy and target.

c) Promotion of the Master Plan

i) Principle for Promotion of the Master Plan

The principle for promotion of the Master Plan shall be specified, to which the PDCA (Plan, Do, Check, Action) cycle shall be applied.

ii) Organization for Promotion of the Master Plan

To promote the Master Plan, the organization with the role shall be prepared with the participation of Central Government, local governments and local communities.

iii) Action Plan

To promote the Master Plan, an action plan shall be prepared.

iv) Model Project

As pilot projects for the Master Plan, several model projects shall be provided in accordance with the basic concept and strategy of the Master Plan.

v) Institutional Arrangement

Implementation of the under the current institutional framework shall be confirmed, and additional institutional arrangement shall be examined, if necessary.

3.3.2 Basic Strategy of Watershed Management

The basic strategy of watershed management under the Master Plan focuses on the following points:

- (1) To assure the safety of the Tsurumi River from floods.
- (2) To assure the clean and enough lower water.
- (3) To provide a better environment as the amenity for the local inhabitants together with the preservation of echo-system.

Under the strategy, the outline of the water management is as given below:

1) Flood Management

a) Sub-strategy

Under the strategy “to assure the safety of the Tsurumi River from floods”, the following sub-strategies shall be set up:

- (i) To assure the safety against large scale floods.
- (ii) To alleviate flood damage in the areas hit by extraordinary local heavy rainfall.

b) Target

The following targets shall be provided to fulfill these sub strategies:

- (i) As the target year, the period of 20-30 years shall be considered.
- (ii) Evacuation system to relief inhabitants even such extraordinary local heavy rainfall shall be provided.

c) Conceivable Measures

As the conceivable measures to achieve the target, the following items shall be examined:

- (i) Measures with retention and retarding functions of the basin (retention and detention pond, retarding basin, land use control, etc.)
- (ii) Measures to confine the flood discharge in the river channel (river channel improvement, diversion channel, etc.)
- (iii) Measures to assure the drainage capacity (drainage system improvement, etc.)
- (iv) Measures to strengthen waterproofing of the urban area (land reclamation, etc.)
- (v) Measures to provide necessary information during flood (F/F system, etc.)

2) Low Water Improvement

a) Sub-strategy

The following sub-strategies shall be taken up to assure the strategy “to assure the clean and enough lower water”:

- (i) To assure enough flow regime.
- (ii) To restore clean water flow.
- (iii) To utilize the precious water efficiently.

b) Target

The following targets shall be provided to fulfill these sub-strategies:

- (i) To restore the low water flow regime condition before urban development.
- (ii) To preserve the groundwater and restore the water spring.
- (iii) To restore the water quality, where a variety of water lives can inhabit.
- (iv) To establish a society with less water consumption and water recycle

c) Conceivable Measures

As the conceivable measures to achieve the target, the following shall be examined:

- (i) Measures to preserve infiltration capacity of ground in the basin
- (ii) Measures to preserve spring and ground water
- (iii) Measures to restore flow regime in the river channel
- (iv) Measures to restore flow regime in the stream and drainage channel
- (v) Measures to control pollution from non-point source in the basin
- (vi) Measures for water quality improvement in sewer
- (vii) Measures for water quality improvement in the river channel
- (viii) Measures for rainfall harvesting
- (ix) Measures to save domestic and industrial water consumption
- (x) Measures to recycle of water consumed
- (xi) others

3) Amenity and Echo-system

Likewise, management for preservation of better environment shall be examined as to sub-strategies, target and measures. Since the discussion on the matter is still under way, the output is not available. However, the output from the discussion such as target and measures is presumed as follows:

“It is expected that urban development shall be promoted with harmonization of environment, facilities, land use and utilization of riparian space. In this connection, a guideline for river utilization and preservation of natural environment should be arranged and human activities should be encouraged in due consideration of watershed management.”

To achieve the target, the following measures are conceived:

- (a) Improvement of access to the riparian space and promotion of appropriate

utilization of the space

- (b) Constitution of environment reflecting historical events and culture in the riparian space
- (c) Preservation of historical heritage and education on the value of historical heritage
- (d) Encouragement of industries to contribute promotion of favorable water cycle

4. RECOMMENDATION

4.1 Comparison of Watershed Management Activities in both River Basins

As discussed in the previous sections, there are some differences in watershed management activities in both river basins, Lai Nullah and Tsurumi River, which are emphasized with the following points: (1) involvement of stakeholders and local communities and (2) application of several measures to watershed management activities.

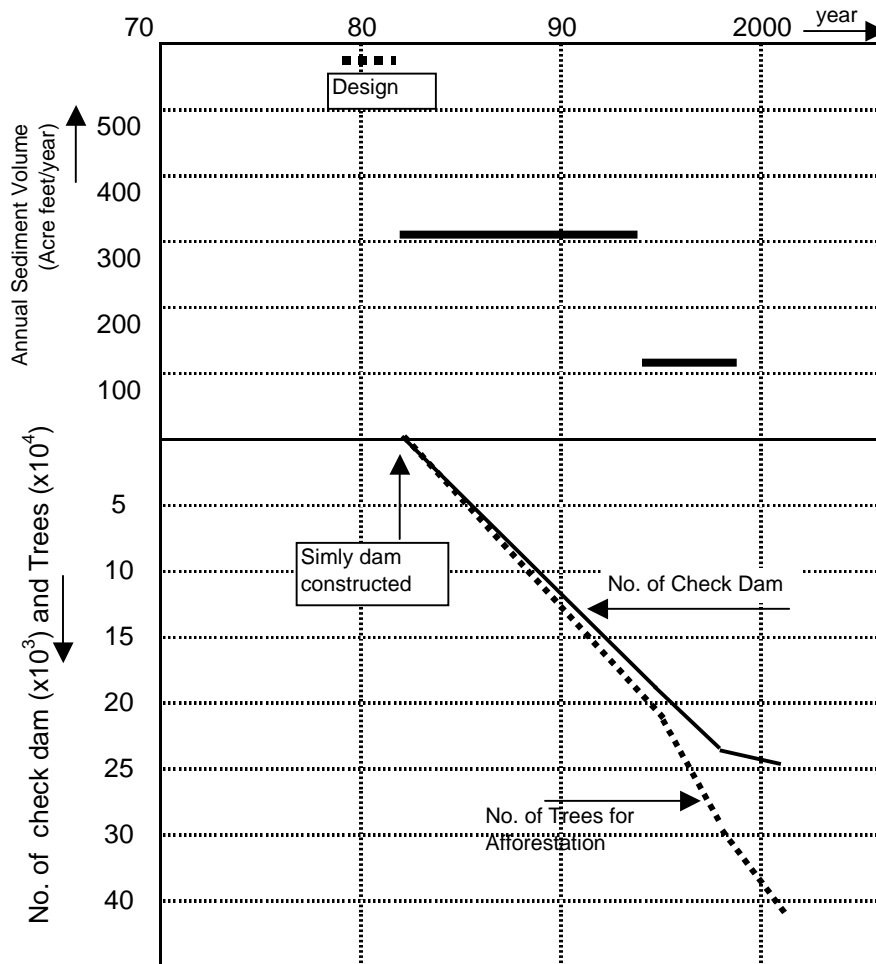
4.2 Recommendation

It may be difficult to directly apply the watershed management activities in Tsurumi River to Lai Nullah due to the difference of cultural and historical backgrounds. However, it is essential to promote the watershed management as much as possible, so that water related issues can be alleviated more practically and effectively. In this sense, the following recommendations are made considering current activities in Lai Nullah:

- (1) The current activities for watershed management in Lai Nullah basin are undertaken to mainly control sediment flowing into reservoirs. In the context of the watershed management, other water related issues such as flood, low water and water environment should be considered even in Lai Nullah, especially flood mitigation. Therefore, such activities for watershed management related to other water issues should be undertaken.
- (2) The activities for watershed management are undertaken by only a few agencies concerned. As introduced in Chapter 3, the watershed management will cover a wide range of water related issues, and thus to solve those problems, participation of various stakeholders including local communities is essential.
- (3) The currently applied measures for watershed management in Lai Nullah and neighboring areas are conventional ones and they will be effective for the respective purposes. However, to enhance the effectiveness for watershed management, introduction of the other measures such as land use control, water conservation measures and utilization of amenity of riparian areas should be considered.

SECTOR K

FIGURES



THE STUDY ON COMPREHENSIVE FLOOD
MITIGATION
AND ENVIRONMENT IMPROVEMENT PLAN
OF LAI NULLAH BASIN

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. K.1

Effectiveness of Watershed Management