Environmentally Sound and Sustainable Dam Construction in Asia  
( Hantan River Dam in Korea )

For activating the local economy of the surrounding area of the Hantan River Dam  
Unil Baek *  
Hyunsun Kim **  
Younghwan Park***  
Seungkyu Noh****

Abstract

Theses days, there are 3 prerequisites for dam building in Korea:
First one is how to build the dam safe and stable from the technical points of view.  
Second one is how to design and construct the dam environmentally sound with the  
minimum change of the surrounding area of the dam site. Third one is how to activate  
the local economy of the surrounding area of the dam site in order to make the dam  
construction sustainable from the social and economical points of view.

As far as technical aspects for dam building, there are hardly any problems in dam  
design and construction in our country. However, there are a little difficulty according  
to the location of the dam site.

In order to fulfill the second option it is believed that a lot of effort should be made  
to accomplish the second task not only because that fairly large area shall be inundated  
with water after impounding but also because that ecological environments shall be  
changed due to change of water environment. Therefore, thoughtful investigation and  
assessment of the environmental features of the local regions have to be preceded before  
starting of the dam building.

In order to overcome these difficulties Hantan river dam has been declared as an  
Eco-dam with 3 strategies and 9 activities plan at the design stage after sufficient  
consideration of the local identities of these region and coupled national plans for  
surrounding areas.

Finally, Eco-tourism with the several coupled network-wise touristic courses, namely  
PERTH model, has been proposed after thorough analysis of the local identities by the  
Jahari window to make local economy being activated.
Detailed descriptions for 3 strategies and 9 activities plan for declaration of Eco-dam and proposal of Eco-tourism with the network-wise touristic courses will be mentioned in the main content.

* PE. Msc., Project Manager of Hantan River Dam of Daelim Ind. Co.
** Dr., C.E.O of khs Design Institute
*** PE. Msc., Deputy Manager of Development Dept. of Samsung Everland
**** Ir., Deputy Manager of Hantan River Dam of Daelim Ind. Co.
1. Technically sustainable development for large dam

To build the Hantan river dam safe and stable, which is situated in the north part of Gyeonggi province with the main purpose of flood protection for lower cities and is located about 20km away from DMZ (De-militarized zone), R.C.C.D (Roller Compacted Concrete Dam) with the concrete volume of 850,000m3 has been adopted with the height of 85m and the length of 709m.

There are 2 specific difficulties in the design of Hantan dam.

First one is how to treat the Baekuiri strata with thickness of 1 to 2 meters, which is consisted of unconsolidated silty sand and gravel and is regarded as an old river bed covered by the volcanic rock with 40 to 50 meters thick from the foundation surface. Second one is how to arrange 14 operational gate facilities (5 gates for emergency spillway at the top of the dam, 4 gates for operating spillway in the middle of the dam, 4 gates for ecological corridors and 1 gate for sedimentation during flood discharge at the bottom of the dam) in the narrow river center of the dam body.

It has been found through thorough site investigations that foundation settlement at HWL after construction of the dam will be in a permissible limit. However, in order to prevent any leakage through the Baekuiri strata a line of upward and downward grout curtain at the center of dam axis has been designed at the basic design stage. The curtain grouting of 10 to 20 meters long on both direction will be performed from one 150 meters long and 3.5 meters diameter of Grouting tunnel along the Baekuiri strata (see Fig.1).

To match with alignment of emergency spillway and operating spillway 18meters wide segment has been adopted in the main stream of the river. Four ecological corridor and 1 sedimentation gate have been arranged outside of the Stilling basin walls (see Fig.2).
Fig. 1 Grouting tunnel

Fig. 2 Layout of the dam
2. Environmentally sustainable development for dam

To make a dam environmentally sound and sustainable, immigration paths of 7 different local inhabitant species, for instance mammal, bird, fish, amphibia and etc. after dam building has been estimated and prepared new dwellings for each species in the upstream and downstream of the dam (see Fig.3). For example, 300,000m² of natural ecological park and 900,000m² of wetland will be constructed in the upstream of the dam. Besides, 100,000m² of downstream park including stream channel and biotope also will be made (see Fig.4). Ecological corridor across the access road and green road at the crest of the dam will be constructed to make ecology moves freely.

Most of time of the year migration fish, crab and plankton will be pass freely through 4x5.6m diameter ecology corridor tunnel at the bottom of the dam. Moreover, while the dam has impounded necessarily, migrating fish may go up from downstream to upstream by 33 meters high fish elevator and land into upstream surface through circular slipway which has been designed in the right side of the dam (see Fig.5).

One of negative effect of river environment by dam building is cutoff of the sediment transport of the river, which leads to breaking of equilibrium of sediment supply from upstream to downstream. Therefore one sediment discharge bypass channel is designed at the left side guide wall of stilling basin to supply sediment to the downstream of the dam during flood season (see Fig.6). Estimated volume of 640,000m³ of sediment per year will be supplied to downstream through the bypass channel.

In order to minimize environmental impact by dam building a lot of hardware facilities with the concept of Eco-dam building to reduce any bad effect have been planned as mentioned above. Besides, 3 development strategies and 9 activities software plan has been declared to keep these facilities sound and sustainable as follows.

- 3 development strategies
  . Development of theme network to maximize substantial resources
  . Enhancement of local econo-cultural community
  . Balanced development between development and conservation

- 9 activities plan
  . Preserve items from the assessment of environmental effect
  . Select location of related facilities to minimize the environmental change
- Design and construction for the dam environment friendly
- Restore temporal environmental change during construction as soon as possible
- Mitigate permanent environmental change after construction
- Create new environment for bio-diversity
- Construct natural ecological park for eco-tourism
- Build base camp for eco-pia
- Provide activity program and routes of eco-tourism

Fig. 3 Monitoring map of immigration paths of 7 different species

Fig. 4 Natural ecological park and wetland
Fig. 5 Ecological corridor and fish elevator

Fig. 6 Sediment discharge bypass channel
3. Socio-economically sustainable development for dam

These days there are a lot of antagonist of dam building, for example upstream inhabitants and environmentalist, for the reason that economical disadvantage due to restrictions of upstream side development for clean water environment becomes greater and environmental bad effect by dam building becomes more important. To minimize these negative effect on surrounding environment of the dam, a lot of effort to reduce environmental impact has been made as mentioned in Chapter 2.

In this chapter considerations for socio-economically sustainable development for dam will be mentioned. In order to satisfy surrounding people of the dam and upstream inhabitants the activating plan of the local economy of the surrounding area of the dam becomes the hot issue in 21st century for the sustainable development of dam. Therefore thoughtful investigation and assessment of the local identities have been preceded to find out local identities and local boosting model for local economic growth as the follow steps.

3.1 Background and Object

<table>
<thead>
<tr>
<th>Motive</th>
<th>Concept</th>
<th>Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Wisdom”</td>
<td>Local identity</td>
<td>Region</td>
</tr>
<tr>
<td>for Solution</td>
<td>Attract the six senses</td>
<td>- Creation of local culture oriented for future</td>
</tr>
<tr>
<td></td>
<td>Public release</td>
<td>- Reflection of regional characteristics</td>
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<td></td>
<td></td>
<td>Economy</td>
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<td></td>
<td></td>
<td>- Development of local residents' stable income</td>
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<tr>
<td></td>
<td></td>
<td>- Positive effect of local economy</td>
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<tr>
<td></td>
<td></td>
<td>Environment</td>
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<tr>
<td></td>
<td></td>
<td>- Conservation of natural environment</td>
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<tr>
<td></td>
<td></td>
<td>- Minimization of environmental impact</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Theme</td>
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<tr>
<td></td>
<td></td>
<td>- Guarantee of surrounding area's development concept</td>
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<tr>
<td></td>
<td></td>
<td>- Secure of tour competitiveness by symbol heightening</td>
</tr>
</tbody>
</table>

Positive Image about Dam Project

Sustainable and Eco-friendly Dam Construction
3.2 Comprehensive Investigation of Major States

To find out the local identities for further development Jaheri’s Window method has been applied. Furthermore, 4 aspects for comprehensive investigation of major states and detailed investigation items have been established as the following table.

<table>
<thead>
<tr>
<th>Motive</th>
<th>Concept</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Region-friendly</strong>&lt;br&gt;Conservative development based on regional status</td>
<td>1. Conservation areas of water resources&lt;br&gt;2. Relocation of military zones&lt;br&gt;3. Hierarchy of aimed and surrounding areas&lt;br&gt;4. Conservation of ecological places/use of tourism resources</td>
<td></td>
</tr>
<tr>
<td><strong>Human-friendly</strong>&lt;br&gt;Short and long term restructuring and profit heightening</td>
<td>1. Stabilization of living conditions&lt;br&gt;2. Recreation of local community&lt;br&gt;3. Minimization of culture impact</td>
<td></td>
</tr>
<tr>
<td><strong>Eco-friendly</strong>&lt;br&gt;Effective utilization of tourism resources and endowment of economic value</td>
<td>1. Measures establishment for the assessment of environmental impact&lt;br&gt;2. Visualization of eco-dam in the forest&lt;br&gt;3. Counter measures for the destruction and restoration of ecology&lt;br&gt;4. Harmony of ecological hardware and software</td>
<td></td>
</tr>
<tr>
<td><strong>Culture-friendly</strong>&lt;br&gt;Restoration and development of cultural resources</td>
<td>1. Restoration and conservation of native culture&lt;br&gt;2. Restoration and conservation planning about cultural resources' damage&lt;br&gt;3. Heightening of local culture identity - tour program/network tour/event program</td>
<td></td>
</tr>
</tbody>
</table>
3.3 Development of Concept

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<table>
<thead>
<tr>
<th>Step</th>
<th>Target Establishment by Steps</th>
<th>Concept</th>
<th>Application Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Step</td>
<td>&quot;Assimilation with nature&quot; Harmonious development with dam construction in the forest and natural ecology</td>
<td>Starting of ECO</td>
<td>• Dam in the forest(Hantan River Dam) construction</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>• Sustainable environmental development project</td>
</tr>
<tr>
<td>2nd Step</td>
<td>&quot;ECO space that culture becomes liveliness&quot; Space invention and making tour resources which are harmonious with nature and native cultures.</td>
<td>Liveliness of ECO</td>
<td>• View development of ECO Dam</td>
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<td></td>
<td></td>
<td></td>
<td>• Local economy activation project</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>- Local residents independence economy program</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Restoration program of development profit to local area</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Culture, tour, a place of interest, activation,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Space and facility plan</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Event, active program practice</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Nature, Ecology, Sustainable environment program</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Stagewise connection project</td>
</tr>
<tr>
<td>3rd Step</td>
<td>&quot;Extension of Economy activation to the neighbor-hood dam area&quot; Connected Network operation with surrounding areas of dam in the forest</td>
<td>Special extension of ECO</td>
<td>• Stagewise sustainable economy program</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Extension program of a place of interest (neighborhood area networks)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Establishment of Management, maintenance, operation systems</td>
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<td></td>
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<td>• Specialized program of Zones</td>
</tr>
</tbody>
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3.4 Master Plan of Activating the local economy

After development concept for activating of local economy has been established, detailed zone facilities has been adopted according to the characteristics of the 6 scattered zones around the dam, which might be a basic constituent of economic block unit.

For getting synergy effects of each zones economy, these zones will be connected either by the relocation road or landscaping bridges and circular road around the dam boundary as shown on the schematized drawing. Besides, migrated residence zones will
be located near to the economic zones. These zones, which are situated within 5 km from the HWL line of dam and being connected by the roads, will be regarded as the economic core for activation of local economy. In order to expand activation areas of local economy PERTH network model, which will be extended 25km from the established economic core, has been proposed together with the local heritage visiting program and eco-tourism.

### 3.4.1 Detailed Zone Facilities plan

#### ① Komun-ri/Bugok-ri Zone
- Environment friendly park (Construction site)
- Right bank plaza of dam
- Hanyeoul wild grass garden

#### ② Unsan-ri Zone
- ECO park
- Environment friendly natural health rest village

#### ③ Chung-ri/Samyul-ri Zone
- Sports park: multipurpose play ground, camping
- Environment friendly agriculture complex
- Hantan River great swampy land / Grassland

#### ④ Daehoesan-ri/Sohoesan-ri Zone
- Sports center, convention center
- Camping site, multipurpose playground
- Program based on age, unit scale, utilization period

#### ⑤ Whajeokyeon Zone
- Theme park based on legend by motives
- Hydrophilic, Environment friendly, culture friendly landscape
- Water garden, picnic site, photography

#### ⑥ Goseokjeong Zone
- Water and leisure facilities
- Impressive view by use of wildflowers
- Goseok-jeong zone activation composition, Military tour course
3.4.2 Zone Connection Plan

<table>
<thead>
<tr>
<th>Distance</th>
<th>&quot;Magnificent view of Water&quot;</th>
<th>&quot;Path of Water&quot;</th>
<th>&quot;Growth of Water&quot;</th>
<th>&quot;Creation of Water&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Northway 3.75km / Southway 4.5km</td>
<td>Northway 5.25km</td>
<td>Beltway 22.5km</td>
<td>Beltway 6.75km / Northway 425km</td>
</tr>
</tbody>
</table>

Sightseeing /Amusement

- Environment friendly park
- PR place of water resources
- Ecology friendly foot road
- Jaein Waterfall, pillar-shaped joint
- Cozy hill and plain
- Great Plains and swampy land
- Farm park
- ECO studying place
- Mountain amusement part
- Hydro power plant
- Concentration of 7 landscape bridges
- Dynamic beltway
- Cultural villages
- Gymnastics
- Camping
- Rafting experience
- Recreation place
- Landscape

User Mind

<table>
<thead>
<tr>
<th>Expectation</th>
<th>Cool</th>
<th>Sufficiency/Diversity</th>
<th>Activation</th>
</tr>
</thead>
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</table>

3.4.3 Migrated Residence Zone (Natural health and Rest Village) Plan

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Nature and Health</th>
<th>Tour Village</th>
<th>Optimum Scale</th>
<th>Adoption of Various Needs</th>
</tr>
</thead>
</table>

Induction Facility and Program

- Pension
- Access road
- Inside view
- Overview
Basic Concept

Detailed facilities of zones compose core of economy activation being connected to landscape roads and bridges, and resulted in economy activation by the extension of networks to wide areas (PERTH Network Model).

Extended Concept

<table>
<thead>
<tr>
<th>Point</th>
<th>Line</th>
<th>Space</th>
</tr>
</thead>
<tbody>
<tr>
<td>Component</td>
<td>Connection</td>
<td>Extension</td>
</tr>
<tr>
<td>part of Core</td>
<td>of Core by roads</td>
<td>to Network</td>
</tr>
</tbody>
</table>

PEACE Network  | ECO Network  | RELICS Network | THERAPY Network | HYDRO Network |
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><img src="image1" alt="PEACE Network" /></td>
<td><img src="image2" alt="ECO Network" /></td>
<td><img src="image3" alt="RELICS Network" /></td>
<td><img src="image4" alt="THERAPY Network" /></td>
<td><img src="image5" alt="HYDRO Network" /></td>
</tr>
</tbody>
</table>
4. Conclusion

It is commonly known these days that there are a lot of antagonist of dam building, for example upstream inhabitants and environmentalist, for the reason that economical disadvantage due to restrictions of upstream side development for clean water environment becomes greater and environmental bad effect by dam building becomes more important respectively.

To minimize these negative effects on surrounding environment of the dam, a lot of effort to reduce environmental impact has been made as mentioned in Chapter 2.

In chapter 3 considerations for socio-economically sustainable development for dam have been mentioned. In order to satisfy surrounding people of the dam and upstream inhabitants the activating plan of the local economy of the surrounding area of the dam becomes the hot issue in 21st century for the sustainable development of dam. Therefore for local economic activation plan has been proposed, so called PERTH network-wise model on the basis of dam building and development of surrounding area of dam, after that thoughtful investigation and assessment of the local identities have been preceded to find out boosting model for local economic growth.