Asian Development Bank
TA 4669-CAM

Technical Assistance to the Kingdom of Cambodia for the Study of the Influence of Built Structures on the Fisheries of the Tonle Sap (financed by the Government of Finland)

Database Component

DATABASE DOCUMENTATION

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April 2007

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PURPOSE OF THE DATABASE COMPONENT OF THE PROJECT

The main task of the database component of the Built Structures project is to prepare a database of existing surface water and surface water quality related structural works in the Tonle Sap Basin. The database should contain the geographic extent and characteristics of these structures.

The database will be used in the assessment of the consequences of built structures on the environmental and human components of the lake ecosystem.

A built structure is defined here as a structure that
- (i) opposes water outflow (e.g. dams, weirs, irrigation schemes, levees, embankments);
- (ii) prevents water inflow (e.g. . roads, railways, flood control works, polders, dykes, wharves and quays);
- (iii) alters water inflow or outflow (e.g. drainage canals, diversion structures, agricultural works, and flow modifications);
- (iv) may degrade water quality (e.g. plants with aqueous effluents, mining and mineral processing facilities, petroleum storage facilities, sewerage systems, and dredges); and
- (v) Fishing gears that can alter hydrological flows and obstruct fish movement.

The main emphasis of the database is on structures of type (i), (ii) and (v).

CLASSIFICATION OF BUILT STRUCTURES

The structures are grouped in the database using structure type classification, derived from structure type and usage. The type classification
1. Assigns exactly one type class for each existing structure in the target area,
2. Determines what characteristics of a given structure are stored in the database,
3. Aids database users in searching for structures that have specific impacts,
4. Is easy to understand for the database user.

STRUCTURE TYPE CLASSIFICATION

1   Storage
110   Reservoir
120   Floodwater storage

2   Flow route
210   Canal
211   Irrigation canal
210   Bridge
230   Culvert
240   Spillway

3   Flow control
310   Dam
320   Embankment
321   Road embankment primary road
322   Road embankment other
323   Railroad embankment
324   Reservoir dike
330   Gate
340   Weir
350   Pumping station
360   Hydropower station
370   Measurement station
371   Hydrological station
372   Meteorological station

4   Fish and aquaculture
410   Fishing gear
411   Dai fishery
412   River barrage with bagnet or trap
413   Fence system fence
414   Fence system trap
415   Fence system pen
420   Fishway
430   Aquaculture
431   Fish pond
432   Fish cage
440   Fishing lot
450   Fish sanctuary

5   Erosion prevention
510   Reinforced bank
520   RipRap

6   Agriculture
610   Rice field
620   Field crops
630   Plantation
640   Other agriculture
650   Irrigated area

7   Transportation
710   Docks/Harbour
720   Breakwater
730   Ferry

8   Discharge
810   Point source
811   Sewage treatment plant
812   Sewage outlet
813   Industrial sewage outlet
814   Mine
820   Diffuse source
821   Scattered population

Structure attributes are values that describe a given structure and are stored in the database. The following data is stored:

- Structure name
- Structure position (mid-point position), UTM (Universal Transverse Mercator, zone 48N with false easting of 500000, and WGS84 datum)
- Structure outline, mid-line or point location, coordinate system as above
- Structure creation (and demolition) date
- Database diary data; entry date and user ID
- Main physical dimensions of the structure
- Main hydrological characteristics of the structure
- Photographs of the structure

Below is a table of attributes based on the above structure classification.

Attributes for all classes

Field	Type	Unit	Explanation
id	Int	-	Structure identifier
class_id	Int	-	Structure class identifier
name	String	-	Name of structure
info	String	-	Additional information in text format
xpos	Real	m	x-coordinate of mid-point (UTM)
ypos	Real	m	y-coordinate of mid-point (UTM)
boundary	Geom	-	Boundary/mid-line/mid-point data
constructed	Date	-	Construction date (when taken to use)
demolished	Date	-	Demolition date (when taken out of use)
entrydate	Date	-	Date when entered into database
entryby	String	-	Userid of user who created this entry
datasource	String	-	Datasource acronym
srid	Int	-	Coordinate system identifier
boundary	Geom	-	Mid-point/boundary/mid-line geometry data

Class-dependent attributes

Field	Type	Unit	Explanation
width	Real	m	Width of structure
height	Real	m	Height of structure
length	Real	m	Length of structure
area	Real	m^2	Area or structure (at the maximum water level)
activestorage	Real	m^3	Storage volume between minimum and maximum water levels
minlevel	Real	m	Water level at which flow out or through a structure stops
maxdepth	Real	m	Maximum water level for a structure
crestlevel	Real	m	Minimum water level for flow to occur over structure
maxflow	Real	m^3/s	Maximum flow on maximum water level
crsection	Real	m^2	Channel/opening cross section area at maximum water level
wldrop	Real	m	Water level drop over structure
material	String	-	Construction material, e.g. timber/earth/stones/concrete/metal

| production | Real | kg/a | Approximate production per year |

SELECTION CRITERIA FOR STRUCTURES

SPATIAL EXTENT

The database contains structures in the Tonle Sap Basin as defined by the watershed boundary. Spatial emphasis is on the areas through which water flows to the Tonle Sap, and more generally on areas that are or have been under water during the flood season. The Tonle Sap flooded area is shown in Figure 1 and is mostly limited by National Roads nº 5 and 6. The project target sites in Preak Toal, Pursat and Chinit are included in the database with some more detail.
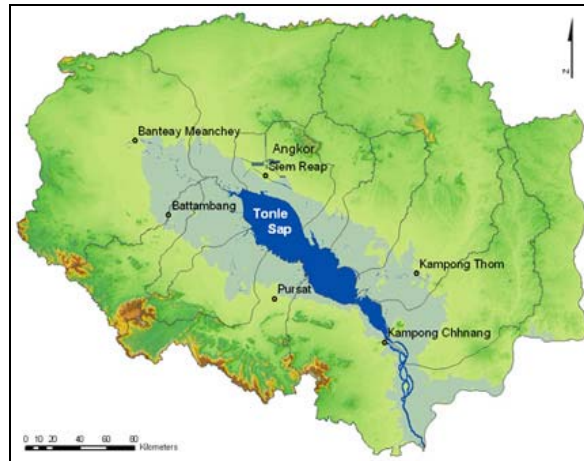

Figure 1: Geographic boundary for database contents

FLOW IMPACT CLASSIFICATION

Structures in the area are divided roughly into three categories according the impact of the structure on water flow. The classes are large, mid-size and small structure. Large structures may have catchment scale impacts, mid-size structures have regional scale impacts, and small-scale structures have only local impacts.

A limit for large structures is here defined as a structure that can store at least 2.5 million m^3 water (in a year), or modify existing flows for at least 1 m^3/s on average, or 4 m^3/s during peak flow time.

A limit for mid-size structures is defined as a structure that can store at least 0.5 million m^3 water (in a year), or modify existing flows for at least 0.5 m^3/s on average, or 2 m^3/s during peak flow time.

Structures that store water modify flows less than mid-size structures that belong to the small category.

The database mainly contains large and mid-size structures. Structures classified as small may also be included in the database in some cases, for example, if the impact of a structure is not known or the attributes required for assessing the structure size are not available.

DATABASE

The data is put into a relational database with the capability to store geometry types MySQL database version 5.0.21 is used here. The MySQL database is free, and contains user friendly tools for installation, database management, and queries. Also, tools for data import from shapefile to the database are available.

A map-based data viewer Java applet was constructed to allow remote access to the database data using an Internet browser.

Export of data to and from the database to GIS programs can be done by writing selected database contents to an ESRI shapefile. The shapefile attribute table will contain selected structure properties.

DATABASE TABLES

The database contains the following tables:
- Structure table – table for storing structure attributes
- Class table – table for storing structure classification data
- Photo table – table for storing photographs of structures
- Contact table – table for storing contact information for structure managers, database users and data sources
- Validation table – table for storing validation data
- Discharge table – table for storing point load data
- Area table – geographic data that can be used to geographically select structure data, for example, catchment boundaries, main rivers, districts and province boundaries, and main settlement locations.

Structure table

Since many types of structures have common attributes, all structures are put in to a single table that has a set of attributes shown below. The list of attributes can be extended if required. Not all attributes are relevant to all structures, so only the relevant attributes, defined by the structure class, will be set for each structure. The irrelevant attributes will have undefined (null) values.

Field	Type	Unit	Explanation
id	Int	-	Structure identifier
class_id	Int	-	Structure class identifier
name	String	-	Name of structure
info	String	-	Additional information in text format
xpos	Real	m	x-coordinate of mid-point (UTM)
ypos	Real	m	y-coordinate of mid-point (UTM)
boundary	Geom	-	Boundary/mid-line/mid-point data
constructed	Date	-	Construction date (when put into use)
demolished	Date	-	Demolition date (when taken out of use)
entrydate	Date	-	Date when entered into database
entryby	String	-	Userid of user who created this entry
datasource	String	-	Datasource acronym
srid	Int	-	Coordinate system identifier
boundary	Geom	-	Mid-point/boundary/mid-line geometry data
width	Real	m	Width of structure
height	Real	m	Height of structure
length	Real	m	Length of structure

area	Real	m^2	Area of structure (at the maximum water level)
activestorage	Real	m^3	Storage volume between minimum and maximum water levels
minlevel	Real	m	Water level at which flow out or through a structure stops
maxdepth	Real	m	Maximum water level for a structure
crestlevel	Real	m	Minimum water level for flow to occur over structure
maxflow	Real	m^3/s	Maximum flow on maximum water level
crsection	Real	m^2	Channel/opening cross section area at maximum water level
wldrop	Real	m	Water level drop over structure
material	String	-	Construction material, e.g. timber/earth/stone/concrete/metal
production	Real	kg/a	Approximate production per year

Class table

The class table contains data on structure classes.

Field	Type	Unit	Explanation
id	Int	-	Structure class identifier
name	String	-	Name of class
parent	Int	-	Identifier of parent class
description	String	-	Description of the class
shapetype	tinyint	-	Shape type point/polyline/polygone
linecolor	Integer	-	RGB linecolor (256*R+256*(G+B))
linestyle	tinyint	-	Line style: 0=thin, 1=medium, 2=thick, 3=dashed
fillcolor	integer	-	RGB fillcolor (256*R+256*(G+B))
fillstyle	tinyint	-	Fill style, 0=solid, 1-28 hatch: 1: ' ' , 4: '\\\\', 7: '///', 10: '|||', 13:'xx' , 16:'++'; +0=dense, +1=medium, +2=sparse

Photo table

The photo table contains photos that can be added to structure descriptions. Photos are stored using a maximum size of 1600x1200 pixels and in .jpeg format.

Field	Type	Unit	Explanation
id	Int	-	Photo identifier
structure_id	Int	-	Structure identifier
image	BLOB	-	Photograph data (.jpeg 1600x1200)
description	String	-	Photo description
priority	Int	-	Photo presentation order, smaller first
date	date	-	Date photo was taken
ypos	Real	m	Photo position X-coordinate (UTM)
ypos	Real	m	Photo position Y-coordinate (UTM)
direction	Int	degr.	Direction from structure to photographer, 0=from north, 90=from east side
distance	Real	m	Distance from structure to photographer

Contact table

Table for contact information of database users, data sources and structure managers.

Field	Type	Unit	Explanation
id	Int	-	Contact identifier
acronym	String	-	Acronym
firstname	String	-	Firstname
lastname	String	-	Lastname
userid	String	-	Database userid, if exist
institute	String		Institute
department	String		Department
address1	String	-	Street address
address2	String	-	Post number and city
phone1	String		Phone number
phone2	String	-	Mobile phone number
fax	String	-	Fax number
email	String	-	Email address
date	Date	-	Date of last update

Validation table

Table for structure validation data.

Field	Type	Unit	Explanation
id	Int	-	Validation identifier
structure_id	Int	-	Structure identifier
contact_id	Int	-	Validator identifier
validated	Date	-	Date of validation
method	String	-	Validation method; visit/indirect
description	String	-	If anything was changed

Discharge table

Table for discharge data.

Field	Type	Unit	Explanation
id	Int	-	Load identifier
structure_id	Int	-	Associated structure
substance	String	-	Load variable, e.g. PTOT, NTOT
amount	Real	kg/d	Amount of load per day
dyear	Int	-	Year for discharge

Area table

Table for selection data.

Field	Type	Unit	Explanation
id	Int	-	Area identifier
name	String	-	Area name
type	String	-	Catchment/district/river/settlement/road
area	Double	m^2	Area of boundary
boundary	Geometry	-	Area boundary

110 Reservoir

Class-dependent attributes

Attribute	Type	Unit	Explanation
*info	String	-	Reservoir owner (owner: name)
width	Real	m	Reservoir extent (bounding box width) in east-west direction
length	Real	m	Reservoir extent (bounding box height) in north-south direction
area	Real	km2	Area of reservoir at the maximum water level
activestorage	Real	m3	Active storage of the reservoir
minlevel	Real	m	Water level at which outflow from the storage stops
maxdepth	Real	m	Difference from minlevel to activestorage level

Selection criteria

Large: Reservoirs with a volume larger than 2.5 million m^3. For typical reservoirs in the area with a water depth of 0-2 meters, this would mean an area of at least 2.5 km^2 when 1 m average water depth is used in volume computation.

Midsize: Reservoirs with a volume 0.5-2.5 million m^3. For typical reservoirs in the area with a water depth of 0-2 meters, this would mean an area of at least 0.5 km^2 when 1 m average active depth is used in volume computation.

Reservoirs that are next to each other are included in the database if the combined estimated volume exceeds the above criteria.

Source data

- source data JICA reservoirs (ts_reservoir2.shp),
  - attributes: boundary, name and area

Data processing

- reservoirs with area smaller than 0.5 km^2 dropped out
- selection criteria applied to original data

120 Floodwater_storage

Class-dependent attributes

Attribute	Type	Unit	Explanation
*info	String		Storage owner (owner: name)
width	Real	m	Storage extent (bounding box width) in east-west direction
length	Real	m	Storage extent (bounding box height) in north-south direction
area	Real	km2	Area of storage at the maximum water level
activestorage	Real	m3	active storage of the reservoir
minlevel	Real	m	Water level at which flow to/from the storage stops
maxdepth	Real	m	Difference from minlevel to water level at activestorage volume

Selection criteria

– same as for reservoirs (class 110)

Source data

- source data Kampong Thom private reservoirs, Agriculture Office Kampong Thom Province (kt_reservoir.shp)
  - attributes: boundary, owner, area

Data processing

- no addition processing

210 Canal

Class-dependent attributes

Attribute	Type	Unit	Explanation
width	Real	m	Channel/opening width perpendicular to flow direction
length	Real	m	Channel/opening length along flow
minlevel	Real	m	Channel bottom level
maxdepth	Real	m	Channel depth from minlevel to bank level
crsection	Real	m2	Channel cross section area at maxlevel
material	String		

Selection criteria

Large: Canals with an average flow larger than $1m^3/s$, or a peak flow larger than $10m^3/s$. Channels with high water cross section larger than 10 m^2
Midsize: All channels wider than 2 meters

Source data

- no data

Data processing

- no addition processing

211 Irrigation canal

Class-dependent attributes

Attribute	Type	Unit	Explanation
width	Real	m	Channel width perpendicular to flow direction
length	Real	m	Channel length along flow
minlevel	Real	m	Channel bottom level
maxdepth	Real	m	Channel depth from minlevel to bank level
crsection	Real	m2	Channel cross section area at maxlevel
material	String	-	Bank material, if not earth

Selection criteria
- same as canal (class 210)

Source data
- source data JICA irrigation channel data (ts_irr_canal2.shp)
  - all data included
  - attributes: mid-line, small/large size classification
- source data Chinit irrigation project channel data (added ts_reservoir2.shp)
  - all data included
  - attributes: mid-line, size: main/secondary/tertiary canal/drain

Data processing
- simplified data to 10 meter resolution
- split with catchment boundaries

220 Bridge

Class-dependent attributes

Attribute	Type	Unit	Explanation
width	Real	m	Channel/opening width perpendicular to flow direction
height	Real	m	Height of bridge bottom from dry-season water level
length	Real	m	Channel/opening length along flow
minlevel	Real	m	Bridge opening bottom level
maxdepth	Real	m	Typical maximum water depth under bridge
crsection	Real	m2	Channel/opening cross section area at maxlevel
material	String	-	Material

Selection criteria
> *Large*: Bridges longer than 30 meters
> *Midsize*: Bridges longer than 5 meters

Source data
- source data JICA map road bridges (ts_rd_bridge.shp)
  - all bridges included
  - attributes: location

- source data JICA map railroad bridges (ts_rr_bridge.shp)
  - all bridges included
  - attributes: location

Data processing
- no additional processing

230 Culvert

Class-dependent attributes

Attribute	Type	Unit	Explanation
*info	String		Culvert type, pipe/box
width	Real	m	Width perpendicular to flow direction
height	Real	m	Height of culvert opening
length	Real	m	Length along flow
minlevel	Real	m	Culvert bottom level
maxdepth	Real	m	Culvert maximum water depth
crsection	Real	m2	Cross section area at maxdepth
wldrop	Real	m	Difference of height from start to end of culvert
material	String		Material, if not earth

Selection criteria
- all culverts included

Source data
- source data (ts_culvert2.shp)
  - attributes: location, culvert type box/pipe, construction year

Data processing
- Culverts with no completion year dropped out

240 Spillway

Class-dependent attributes

Attribute	Type	Unit	Explanation
width	Real	m	Channel/opening width perpendicular to flow direction
length	Real	m	Channel/opening length along flow
minlevel	Real	m2	Minimum water level for flow to occur over structure
maxdepth	Real	m2	Typical maximum water depth
crsection	Real	m2	Cross-section area
wldrop	Real	m	Water level drop over the length of structure
material	String		Bank material, if not earth

Selection criteria
- all data included

Source data

- field visit data from Chinit
    - attributes: width, length, wldrop

Data processing

- no additional processing

310 Dam

Class-dependent attributes

Attribute	Type	Unit	Explanation
width	Real	m	Width of structure/opening perpendicular to flow direction
height	Real	m	Largest height of dam
length	Real	m	Length of flow path in structure along flow direction
crestlevel	Real	m	Minimum water level for flow to occur over structure
material	String	-	Timber/earth/stone/concrete/metal

Selection criteria

Large: Dams with active reservoir volume larger than 2.5 million m3
Midsize: Dams with active reservoir volume between 0.5-2.5 million m3

Source data

- source data JICA map (ts_dam_earth2.shp)
    - attributes: boundary, material

Data processing

- all data included
- joined lines
- simplified to 10 m resolution

320 Embankment

Class-dependent attributes

Attribute	Type	Unit	Explanation
width	Real	m	Width of structure
height	Real	m	Average height of embankment from ground level
length	Real	m	Length of embankment
crestlevel	Real	m	Minimum water level for flow to occur over structure
material	String	-	Timber/soil/concrete/metal

Selection criteria

Large: Any embankment potentially catching water for more than 2.5 million m^3, or, an embankment longer that 10 km.
*Midsize***:** Embankments higher than 1 m if longer than 2 km. Also, other embankments that potentially trap more than 0.5 million m^3 of water.

Source data

- source data JICA embankments (ts_levee3.shp)
  - attributes: boundary, material, length

Data processing

- joined lines
- dropped out embankments shorter than 0.8 km, and not within distance of 0.5 km of a selected embankment
- simplified to 10 m resolution
- split with catchment boundaries

321 Road embankment (primary)

Class-dependent attributes

Attribute	Type	Unit	Explanation
width	Real	m	Width of structure
height	Real	m	Average height of embankment from ground level
length	Real	m	Length of embankment
crestlevel	Real	m	Minimum water level for flow to occur over structure
material	String	-	Timber/soil/concrete/metal

Selection criteria

- all data included

Source data

- source data JICA primary roads (ts_rdprimary2.shp)
  - attributes: boundary, length

Data processing

- split with catchment boundaries
- set the crestlevel to 12 meters (equal to above flood)

322 Road embankment (other)

Class-dependent attributes

Attribute	Type	Unit	Explanation
width	Real	m	Width of structure
height	Real	m	Average height of embankment from ground level
length	Real	m	Length of embankment
crestlevel	Real	m	Minimum water level for flow to occur over structure
material	String	-	Timber/soil/concrete/metal

Selection criteria

- all data included (no knowledge on embankment heights available)

Source data
- source data JICA secondary roads (ts_rdsecondary2.shp)
  - attributes: boundary, length

Data processing
- simplified data to 25 meter resolution
- split with catchment boundaries

323 Railroad embankment

Class-dependent attributes

Attribute	Type	Unit	Explanation
width	Real	m	Width of structure
height	Real	m	Average height of embankment from ground level
length	Real	m	Length of embankment
crestlevel	Real	m	Minimum water level for flow to occur over structure
material	String	-	Timber/soil/concrete/metal

Selection criteria
- all data included

Source data
- source data JICA railroads (ts_railway2.shp)
  - attributes: boundary, length

Data processing
- joined lines
- simplified data to 25 meter resolution
- split with catchment boundaries
- set crestlevel to 12 (above flood)

324 Reservoir dike

Class-dependent attributes

Attribute	Type	Unit	Explanation
width	Real	m	Width of structure
height	Real	m	Largest height of dike from ground level
length	Real	m	Length of dike
crestlevel	Real	m	Minimum water level for flow to occur over structure
material	String	-	Timber/earth/stone/concrete/metal

Selection criteria
- see reservoir

Source data
- source data Chinit irrigation project data (chinit_embankment.shp)
  - attribute: boundary, width, length

Data processing
- no additional processing

330 Gate

Class-dependent attributes

Attribute	Type	Unit	Explanation
width	Real	m	Width of gate perpendicular to flow direction
height	Real	m	Height of gate from bottom to max water level
length	Real	m	Length of flow path in gate along flow direction
minlevel	Real	m	Min water level on which flow can occur through the gate
maxdepth	Real	m	Typical maximum water depth for gate
crsection	Real	m2	Cross section though which water can flow at maxdepth
material	String	-	Timber/earth/stone/concrete/metal

Selection criteria
> *Large*: Gate with width of at least 3.0 meters
> *Midsize*: Gate with width of 1.0 to 3.0 meters

Source data
- field survey data

Data processing
- no additional processing

340 Weir

Class-dependent attributes

Attribute	Type	Unit	Explanation
width	Real	m	Width of weir perpendicular to flow direction
height	Real	m	Height of weir
length	Real	m	Length of weir flow path in flow direction
crestlevel	Real	m	Minimum water level for flow to occur over structure
wldrop	Real	m	Water level drop (typical)
material	String	-	Timber/earth/stone/concrete/metal

Selection criteria
> *Large*: Weir with width of at least 30 meters
> *Midsize*: Weir with width of 2.0 to 30 meters

Source data
- source data Chinit irrigation project data (chinit_weir.shp)
  - attributes: length, wldrop, material

Data processing
- no additional processing

350 Pumping station

Class-dependent attributes

Attribute	Type	Unit	Explanation
minlevel	Real	m	Minimum water level where the station can work
production	Real	m3/s	Maximum pumping capacity

Selection criteria

Large: Station with capacity of at least 2 m3/s
Midsize: Station with capacity over 0.5 m3/s

Source data

- no data

Data processing

- no additional processing

360 Hydropower station

Class-dependent attributes

Attribute	Type	Unit	Explanation
minlevel	Real	m	Min water level on which flow can occur through the structure
maxdepth	Real	m	Typical maximum water depth from minlevel
maxflow	Real	m3	Maximum flow though structure on maximum water level
wldrop	Real	m	Water level drop (maxlevel to bottom of structure)
production	Real	Gwh	Annual hydropower production

Selection criteria

Large: Station with production over 50 Gwh
Midsize: Station with production less than 50 Gwh

Data processing

- no additional processing

370 Measurement station

Class-dependent attributes

Attribute	Type	Unit	Explanation
*info	Real	m	Type of station: automatic/manual, measured variable(s)

Selection criteria

- all data stations included

Data processing

- no additional processing

371 Hydrological station

Class-dependent attributes

Attribute	Type	Unit	Explanation
*info	Real	m	Type of station: automatic/manual, measured variable(s)

Selection criteria
- all data stations included

Source data
- source data MOWRAM water level stations (river_station.shp)
  - attributes: location, station id code, measured variables

Data processing
- no additional processing

372 Meteorological station

Class-dependent attributes

Attribute	Type	Unit	Explanation
*info	Real	m	Type of station: automatic/manual, measured variable(s)

Selection criteria
- all data stations included

Source data
- source data MPWT rainfall stations (rainfall_st.shp)
  - attributes: location, station id, measured variables

Data processing
- no additional processing

410 Fishing gear

Class-dependent attributes

Attribute	Type	Unit	Explanation
production	Real	kg/a	Approximate production in one year

Selection criteria
- stationary gears included

Data processing
- no additional processing

411 Dai fishery

Class-dependent attributes

Attribute	Type	Unit	Explanation
width	Real	m	Number of nets
production	Real	kg/a	Approximate production in one year

Selection criteria
- all known dai fisheries included

Source data
- satellite picture from Google Earth
  - attributes: boundary, number of nets

Data processing
- no additional processing

412 River barrage with bagnet or trap

Class-dependent attributes

Attribute	Type	Unit	Explanation
width	Real	m	Width of barrage
production	Real	kg/a	Approximate production in one year

Selection criteria
Large: Barrages longer than 50 meters
Midsize: Barrages between 10-50 meters

Data processing
- no additional processing

413 Fence system fence

Class-dependent attributes

Attribute	Type	Unit	Explanation
length	Real	m	Length of associated fence system (main fence part only)
production	Real	kg/a	Approximate production in one year

Selection criteria
- all fences, traps and pens

Source data
- digitized from aerial photos (fence_pen.shp, fence_trap.shp, fish_fence.shp), Preak Toal area only
  - attributes: boundary, length

Data processing
- no additional processing

414 Fence system pen

Class-dependent attributes

Attribute	Type	Unit	Explanation
length	Real	m	Length of associated fence system (main fence part only)
production	Real	kg/a	Approximate production in one year

Selection criteria
- all fences, traps and pens

Source data
- digitized from aerial photos (fence_pen.shp, fence_trap.shp, fish_fence.shp), Preak Toal area only
    - attributes: boundary, length

Data processing
- no additional processing

413 Fence system rap

Class-dependent attributes

Attribute	Type	Unit	Explanation
length	Real	m	Length of associated fence system (main fence part only)
production	Real	kg/a	Approximate production in one year

Selection criteria
- all fences, traps and pens

Source data
- digitized from aerial photos (fence_pen.shp, fence_trap.shp, fish_fence.shp), Preak Toal area only
    - attributes: boundary, length

Data processing
- no additional processing

420 Fishway

Class-dependent attributes

Attribute	Type	Unit	Explanation
width	Real	m	Channel width perpendicular to flow direction
length	Real	m	Channel length along flow (measured along bank)

crestlevel	Real	m	Minimum water level for flow to occur
crsection	Real	m2	Channel cross section
wldrop	Real	m	Water level drop over the length of structure
material	String		Bank material, if not earth

Selection criteria
- all fishways

Source data
- field trip data from Chinit area
  - attributes: boundary, width, length, wldrop

Data processing
- no additional processing

430 Aquaculture

Class-dependent attributes

Attribute	Type	Unit	Explanation
area	Real	m2	Aquaculture area
production	Real	kg/a	Approximate production in year

Selection criteria
- farms with annual production more than 10 tons per year

Source data
- no data

Data processing
- no additional processing

431 Pond fish farm

Class-dependent attributes

Attribute	Type	Unit	Explanation
area	Real	m2	Aquaculture area
production	Real	kg/a	Approximate production in year

Selection criteria
- same as for aquaculture (class 430)

Source data
- no data

Data processing
- no additional processing

432 Cage fish farm

Class-dependent attributes

Attribute	Type	Unit	Explanation
area	Real	m2	Aquaculture area
production	Real	kg/a	Approximate production in year

Selection criteria
- same as for aquaculture (class 430)

Source data
- no data

Data processing
- no additional processing

440 Fishing lot area

Class-dependent attributes

Attribute	Type	Unit	Explanation
*name	String		Province and number
area	Real	m2	Lot area
production	Real	kg/a	Approximate production in year

Selection criteria
- all fishing lots included

Source data
- source data MRC fishing lots from year 2001 (c_lot2001_commercial_3.shp)
  - attributes: boundary, lot number, area code

Data processing
- extracted commercial lots (type 2) from c_lot2001.shp
- union of lots with same region code and lot number
- simplified to 50 m resolution

450 Fish sanctuary

Class-dependent attributes

Attribute	Type	Unit	Explanation
*name	String		Province and number
area	Real	m2	Lot area

Selection criteria
- all fish sanctuaries included

Source data
- source data MRC fish sanctuaries from year 2001 (c_lot2001_sanctuary.shp)
  - attributes: boundary

Data processing
- extracted sanctuaries (type 3) from c_lot2001.shp
- simplified to 50 m resolution

510 Reinforced bank

Class-dependent attributes

Attribute	Type	Unit	Explanation
width	Real	m	
length	Real	m	
material	String	-	Description of material used

Data processing
- no additional processing

520 RipRap

Class-dependent attributes

Attribute	Type	Unit	Explanation
width	Real	m	Width across flow direction
length	Real	m	Length along flow direction
material	String	-	Description of material used

Selection criteria
- ripraps associated with a structure already in the database

Source data
- field trip data from Chinit area
  - attributes: boundary, width, length, wldrop

Data processing
- no additional processing

610 Rice field

Class-dependent attributes

Attribute	Type	Unit	Explanation
area	Real	km2	Area of structure

Source data
- source data JICA paddy field areas (ts_paddyfield5.shp)
  - attributes: boundary, area

Data processing
- simplified to 50 m resolution
- split to catchment areas
- areas smaller than 0.1 km2 removed

620 Field crops

Class-dependent attributes

Attribute	Type	Unit	Explanation
area	Real	km2	Area of structure

Source data
- source data JICA plantation areas (ts_fieldcrop2.shp)
  - attributes: boundary, area

Data processing
- simplified to 50 m resolution
- areas smaller than 0.1 km2 removed
- split to catchment areas

630 Plantation

Class-dependent attributes

Attribute	Type	Unit	Explanation
area	Real	km2	Area of structure

Source data
- source data JICA plantation areas (ts_plantation2.shp)
  - attributes: boundary, area

Data processing
- simplified to 50 m resolution
- areas smaller than 0.1 km2 removed
- split to catchment areas

640 Other agriculture

Class-dependent attributes

Attribute	Type	Unit	Explanation
area	Real	km2	Area of structure

Source data
- source data JICA agricultural areas (ts_otheragri2.shp)
  - attributes: boundary, area

Data processing
- simplified to 50 m resolution
- areas smaller than 0.1 km2 removed
- split to catchment areas

650 Irrigated area

Class-dependent attributes

Attribute	Type	Unit	Explanation
area	Real	km2	Area of structure

Selection criteria
- Irrigated areas with field area larger than 2.5 km^2

Source data
- source data MRC irrigated areas (ts_irriarea.shp)
  - attributes: boundary, project name, area
- source data Kampong Thom private reservoir areas (kt_irriarea.shp)
  - attributes: boundary, area, owner name

Data processing
- no additional processing

710 Dock/Harbour

Class-dependent attributes

Attribute	Type	Unit	Explanation
length	Real	m	Length of structure

Selection criteria
- all data included

Source data
- no data

Data processing
- no additional processing

720 Breakwater

Class-dependent attributes

Attribute	Type	Unit	Explanation
length	Real	m	Length of structure

Selection criteria
- breakwaters with length of at least 100 meters

Source data
- no data

Data processing
- no additional processing

730 Ferry

Class-dependent attributes

Attribute	Type	Unit	Explanation
length	Real	m	Length of structure

Selection criteria
- all data included

Source data
- source data JICA ferry lines (ts_ferry_line.shp)

Data processing
- no additional processing

810 Point source

Class-dependent attributes

Attribute	Type	Unit	Explanation
production	Real	m3/d	Volume of water coming from outlet

Selection criteria
- waste water flow of at least 100 m3/d, or P load of at least 0.1 kg/d, or N load of at least 1 kg/d, or otherwise non-negligible point source.

Source data
- no data

Data processing
- no additional processing

811 Sewage treatment plant

Class-dependent attributes

Attribute	Type	Unit	Explanation
production	Real	m3/d	Volume of water coming from outlet

Selection criteria
- with waste water flow of at least 100 m3/d

Source data
- no data

Data processing
- no additional processing

812 Sewage outlet

Class-dependent attributes

Attribute	Type	Unit	Explanation
production	Real	m3/d	Volume of water coming from outlet

Selection criteria
- with waste water flow of at least 50 m3/d

Source data
- no data

Data processing
- no additional processing

813 Industrial sewage outlet

Class-dependent attributes

Attribute	Type	Unit	Explanation
production	Real	m3/d	Volume of water coming from outlet

Selection criteria
- with waste water flow of at least 50 m3/d

Source data
- no data

Data processing
- no additional processing

814 Mine

Class-dependent attributes

Attribute	Type	Unit	Explanation
*info	String		Mineral/material, type open-pit/placer/quarry/sub-surface
production	Real	tn	Production of material processed/taken out yearly

Selection criteria
- all data included

Source data
- source data MIME mine data (mine_mime2.shp)

Data processing
- removed points outside Tonle Sap catchment areas

820 Diffuse source

Class-dependent attributes

Attribute	Type	Unit	Explanation
*info	String		Type of source
area	Real	km2	Area of source
width	Real	-	Number of units
height	Real	kg	Production per unit per year
production	Real	units	Total production per year

Source data
- no data

Data processing
- no additional processing

821 Scattered population

Class-dependent attributes

Attribute	Type	Unit	Explanation
*info	String		Type of source, waste produced
area	Real	km2	Area of source
width	Real	-	Number of people
height	Real	kg	Production per person per year
production	Real	units	Total production per year

Selection criteria
- Village ("phum") level division

Source data
- population data from year 1998 (ts_phum2.shp)

- attributes: village position, number of persons

Data processing
- no additional processing

The area table contains the following data:
- Tonle Sap catchment and subcatchment boundaries
  - Data source: MRC (tls_catchments.shp)
  - Attributes: boundary, name, area
- Medium flood extent boundaries
  - Data source: MRC (tls_catchments.shp)
  - Attributes: boundary, name, area
- Cambodian province boundaries (the provinces intesecting Tonle Sap catchment area)
  - Data source: MRC (tls_provicnes.shp)
  - Attributes: boundary, name, area

SYSTEM COMPONENTS AND SETUP

The database system is based on the following MySQL standard software components
- MySQL database server (version 5.0. community edition)
- MySQL Query browser (version 1.1.20)
- MySQL Administrator (version 1.1.9)

Additional tools were created in the project to enable transfer of GIS file data to and from the database server, and to allow data to be shared in internet. These are:
- BSViv tool to access database locally, and to import and export data from ESRI shapefile format
- BSMap tool (a java applet) to view data in internet
- BSConn program (a www-server cgi-program) to retrieve data from database server to BSMap applet

The MySQL database server stores the database data and provides database services to client applications. The MySQL Query browser is an interactive tool that can be used to view and modify the data in the database in the computer that contains the database. Use of the tool requires knowledge of SQL. The Administrator tool is used to manage the database server, for example, create new users and create data backups. The programs are available at the MySQL www-site www.mysql.com free of charge.

The Local database access tool "BSViv" can be used to view, add, and modify structure data on map-based windows application. Also import and export of data to ESRI shape file is possible. This feature can be used, for example, when larger amounts of structure data need to be moved to GIS system. The BSViv program utilizes an open-source GIS tool package called FWTools (version 1.0.7), which can be downloaded from http://fwtools.maptools.org.

The Internet access interface "BSApp" can be used to view database data remotely using an internet browser. To use BSApp a www-server with system html pages and bsconn- cgi-program needs to be setup.

Installation of the system for local and internet access is described in the chapter 2 of the Built Structures Database User Manual.
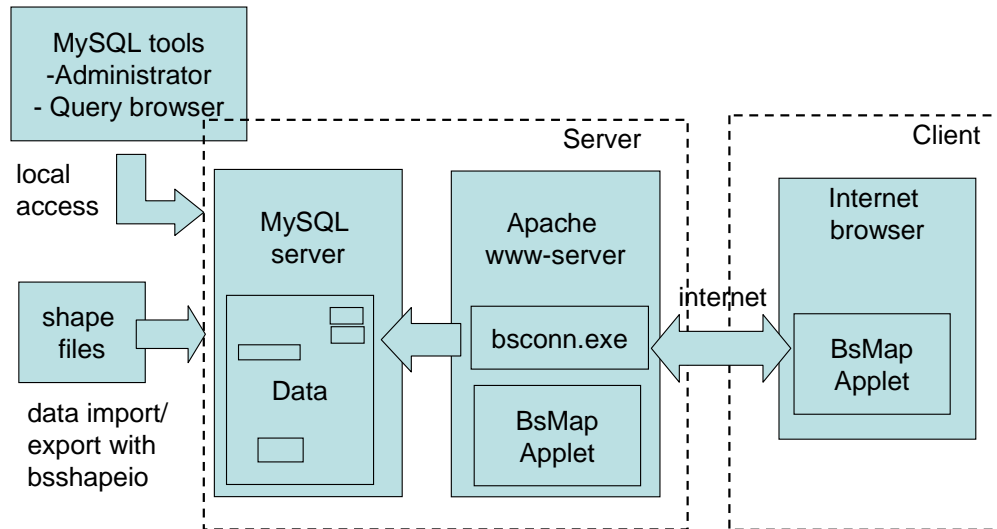

Figure 1: System components and connections

BSVIV APPLICATION FILES

The BSViv application is implemented using a viv-language interpreter, that is developed in EIA Ltd. for simple graphical user interface implementation. The installation will setup the BSViv application under the installation directory to several subdirectories listed below with contents. Starting the program is done by running the "viv.exe" program with the "bs.ip"-file as a parameter.

The viv (=program) subdirectory contains following files:

bs.ip	- program statup file
bsmain.ip	- main program file
common.ip, rl*.ip	- application program files
viv.exe	- ip-file interpreter
vivres.dll, vivbmp.dll	- viv.exe resources and bitmaps, required by viv.exe
rlgis.bmp	- about dialog bitmap file

The map-subdirectory contains following files:

tls_lake.*	- lake and river data for BSViv application
tls_subcatch_utm.*	- subcatchment boundaries for BSViv application

The doc-subdirectory contains following files:

BSApp-help.doc	- BSApp help file
BSDB_manual.doc	- Built structure database system user manual
bsdb_techdoc.doc	- this document

The bsdb-subdirectory contains following files:

bs0.sql	- sql macro to create bs-database tables

```
bs0create.sql          - sql macro to create bs-database
bs0dump.sql            - database dump file
bs0users.sql           - sql macro to setup default database users
classdata.sql          - sql macro to populate structure class data to database
```

WWW-SITE FILES

To access the bs-database using internet, the files listed below need to be setup in a www-server directory. The built structures – site contains BSApp java applet, composed of several jar-files, a bsconn – cgi-bin program, and some html pages.
By defatul user authentication is setup using as in the Apache www-server basic authenication using .htaccess file. The bs-www site countains the following files

```
Main directory: www/bs
        .htaccess              - Apache access control file
        index.html             - startup page
        tlsstart.jpg           - picture in the startup page
        bsapp.shtml            - applet window
        bsapp.jar              - applet code
        openmap.jar            - applet code library
        swingset.jar           - applet code library
        bsapp_help.html        - help window
        exitwindow.html        - file used to exit applet

Help pictures : www/bs/bsapp_help_files
        *.*                    - bsapp_help.html pictures

cgi-bin programs:  www/bs/cgi-bin
        bsconn.exe             - cgi-bin program to connect bsapp to MySQL database
        libmysql.dll           - mysql dll-library, used by bsconn

Documentation: www/bs/doc
        bsdb_manual.doc   - bsdb user manual
        bsdb_techdoc.doc  - this documentation

Apache configuration: wwwconf
        .htpasswd              - password file
        htpasswd.exe           - password generator program
        httpd.conf             - example Apache configuration file
```

DATABASE AND WWW-SITE USER AUTHENTICATION

The user authentication is setup by default for the Apache www-server using basic authentication. Entering the www/bs directory requires giving a user identification and password, after this no more passwords are asked.

The "bsconn" cgi-bin program uses defult username and password (see user manual/Installation) hard coded in the program for accessing MySQL database server. Therefore, it is necessary to setup the default user to the database server if it is to be used via BSApp – applet. If required, the username and password can be easily changed in the bsconn source code.

SOURCE CODE FILES

The bsconn c++ source files and BSApp java source files are included in the "BSSourceSetup.exe" installation package. The bsconn is compiled with Borland C++ builder 6, and the BsApp with Java 1.5.0_08.

APPENDIX A: GLOSSARY

(Reference: http://www.nalms.org/glossary/glossary.htm)

Channel
> A course, such as a trench or aqueduct, through which water is moved or directed; the bed of a river or stream.

Conduit
> Any channel or pipe used for conducting the flow of water.

Culvert
> A hydraulically short conduit which conveys water e.g. through a roadway embankment or through some other type of flow obstruction below ground level.

Dam
> A barrier built across a valley or river for storing water.

Detention basin
> A basin or reservoir where water is stored for regulating a flood. It has outlets for releasing the flows during the floods.

Embankment
> A man-made earth structure constructed for the purpose of impounding water and/or carrying a roadway.

Fish ladder
> An inclined trough which carries water from above to below a dam so that fish can easily swim upstream.

Fishway
> A structure allowing fish to pass over vertical impediments. It may include special attraction devices, entrances, collection and transportation channels, a fish ladder, and an exit.

Gauge (gauging station)
> Specific locations on a stream where systematic observations of hydrologic data are obtained through mechanical or electrical means.

Intake
> A hydraulic structure built at the upstream end of the diversion canal; a tunnel or power plant for controlling the flow and preventing silt and debris from entering the diversion.

Levee
> A natural or man-made earthen barrier along the edge of a stream, river, or lake to prevent the flow of water out of its channel.

Reservoir
> An artificial lake, pond, tank, or basin (natural or man-made) into which water flows and is stored for future use.

Riprap
> A layer of large stones, broken rock, boulders, or precast blocks placed in random fashion on the upstream and downstream faces of embankment dams, on stream banks, on reservoir shores, on the sides of a channel, or on other land surfaces to protect them from erosion caused by current, wind, wave, and/or ice action.

Sluice
> An artificial channel for conducting water, with a valve or gate to regulate the flow.

Sluice gate
> A valve or gate used in a channel to regulate flow.

Spillway

Section of a dam designed to permit water to pass over its crest; a weir or channel taking overflow from the dam; serves as a safety channel to prevent erosion of the dam.

Weir

A dam, usually small, in a stream to raise the water level or divert its flow.

Weir (measurement)

A notch or depression in a levee, dam, embankment, or other barrier across or bordering a stream, through which the flow of water is measured or regulated.

Weir (fish)

A barrier constructed across a stream to divert fish into a trap.

APPENDIX B: TONLE SAP CATCHMENT STATISTICS

(references. MRC hydrology report, 2005, WUP-FIN Tonle Sap modelling project, www.eia.fi/wup-fin)

Catchment area ~ 95000 km^2
Dry season lake ~ volume 1-2 km^3, depth minimum 0.5 m, area 2500 km^2
Rainy season lake ~ volume 50-80 km^3, depth 6-9 m, area 13000-14500 km^2
Lake retention capacity ~ 80 km^3
80 % of sediments brought to lake by flood retained

Average leaching from lake catchment area ~ 30 km^3/a = 10 l/s/km^2
Average volume flowing to lake outside catchment 40 km^3/a

Outflow from lake 7.5-8.5 months, 70.4 km^3, or 3375 m^3/s average for 8 months

Inflow to lake from outside catchment area 40.7 km^3, starting mid-May to mid-June, duration 3.5-4.5 months, 3860 m^3/s average for 4 months

Precipitation ~ 1300 mm/a, typically no rain from December to February
For rainy season, peak precipitation per month is typically over 300 mm/a, or about ¼ of the total yearly precipitation, three times the average precipitation.

Pan evaporation ~ 2100 mm/a = 5.8 mm/d
1 cm water level change in dry season lake level is 2.5 km^3

APPENDIX C: DATA DIRECTORY

JICA data point data
- ts_rr_bridge.shp
- ts_rd_bridge.shp
- ts_culvert.shp
- mine_mime.shp
- ts_hystation.shp

JICA line data
- ts_ferry_line.shp
- ts_railway2.shp
- ts_canal.shp
- ts_levee.shp
- ts_rdprimary2.shp
- ts_dam_earth.shp
- ts_rdsecondary_aw.shp
- ts_rdsecondary_dw.shp

JICA polygon data
- ts_reservoir.shp

MRC data
- Tonle Sap catchment boundary
- Tonle Sap subcatcment boundaries