Development of Global Basins Database (GBDB)

<u>Yuji Masutomi</u> and Yuzuru Matsuoka
Kyoto University

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Motivation and Objectives I
- Development of Global Basins Database-

➢ Global basins database can be used in a broad range of global studies

➢ Global basins database gives

- information of hydrological flow
  - for **modeling**
    - in hydrology, biogeochemistry, ecosystem,…
- appropriate spatial unit
  - for hydrological **assessment and management**

Motivation and Objectives Ⅱ
- Early studies-

- ➢ HYDRO1k: Global hydrological datasets
  - feature
    - comprehensive hydrological datasets
      - basin boundary, stream line, flow direction,…
    - first dataset which are derived from a global 1km-DEM
  - defect
    - low reliability because of no validation with existing data
    - includes only topographical information
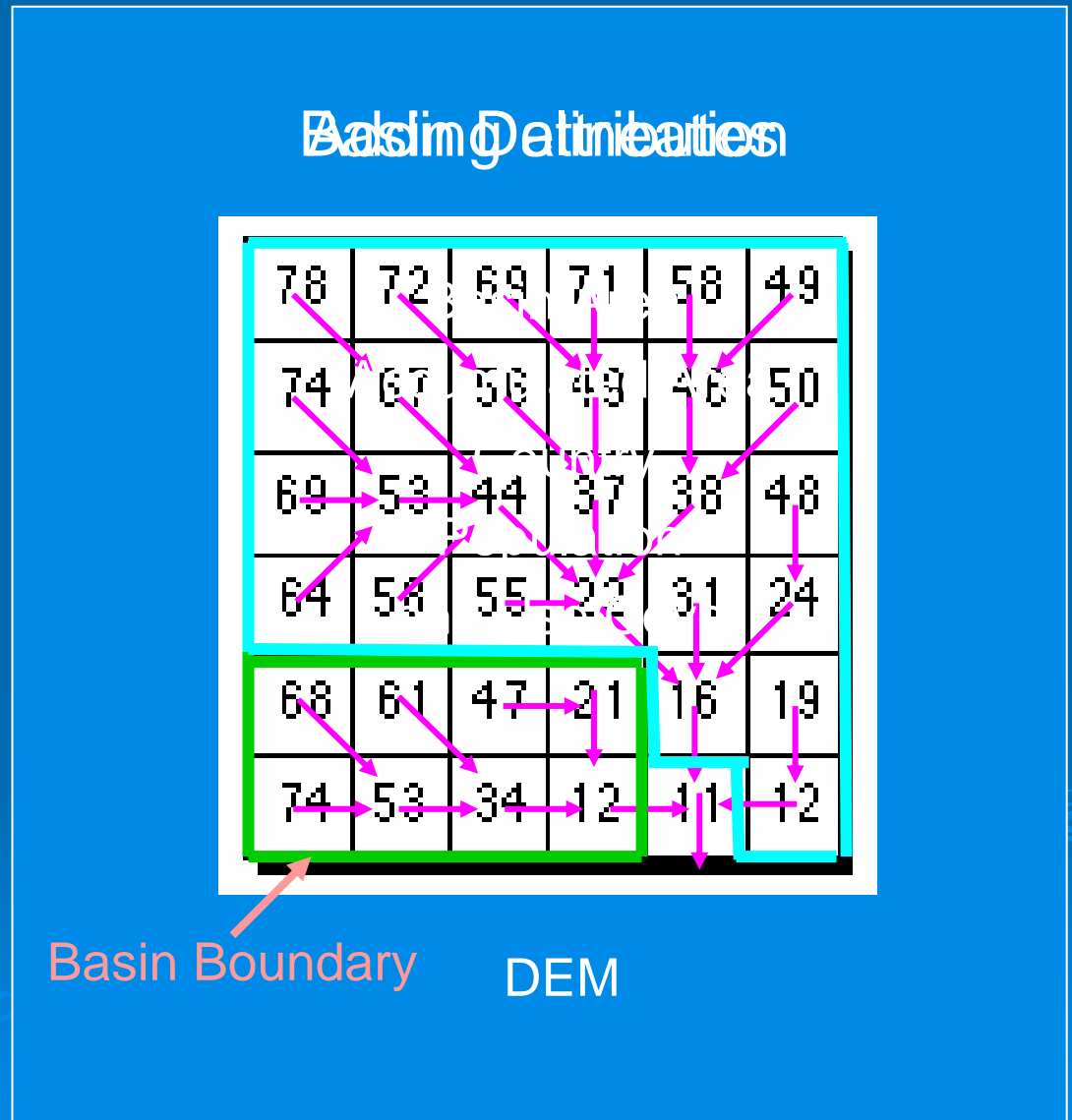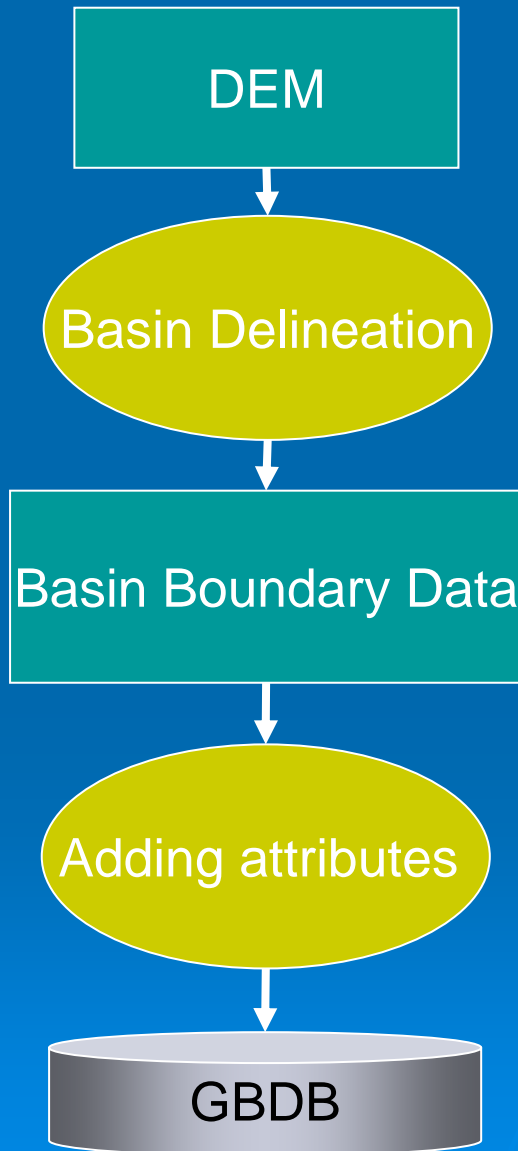
The goal is development of **Global Basins Database** which is

      1. validated and reliable

and includes

      2. not only topographical information but also hydrological, climatic, social,…

Methodology Ⅰ - Outline -

Methodology Ⅱ - Basin Delineation –

- ➤ Raw DEM has many errors to derive incorrect basin boundaries.
- ➤ We used DEM enhanced by Stream Burning method
  - Stream Burning: decreasing the value of DEM along river data

> The generated basin is <u>consistent </u>with river data
> which is used in stream burning method!!

- ➤ River data which are the most reliable for each region are used in Stream Burning method

Stream Burning

River Data	Region	Source
KS-272	Japan	Ministry of Land Infrastructure and Transport(1978)
River-Korea	Korea Peninsula	Korea Environmet Institute
Canadskel_l	Canada	National Resources Canada(2003)
VMAP0	the other regions	Defence Mapping Agency(1993)

Methodology Ⅲ - Basin Delineation -

- In stream burning procedure, some errors are often created.
  - River data error
  - DEM resolution
  - …
- In order to find those errors, we had two comparison with
  - collected basin maps
  - upstream area of river discharge gauging stations
- The generated basin map is compared with collected basin maps
- Calculated upstream area were compared with reported ones at the discharge gauging station provided by Global Runoff Data Center (GRDC)
- If an error was found, DEM would be modified and Basin data would be regenerated from the modified DEM.
- The procedure of comparing and regenerating basin data is iterated until there is no error.

Countr/Basin	Map
Asia	Asia Hydrogeologic Map
Japan	KS-273
	KS-272
Korea	Basin-Korea
Korea Penninsula	River-Korean Peninsula
China	China National Map
	Chinease Hydrological Dictionary
Taiwan	National Atlas of China Vol.1
Vietnam	Atlas du Viet-Nam
	Vietnam Hydrometeorological Atlas
	Hydrological Network
	Catalogue of Rivers For Southeast Asia and The Pacific-Volume I-V
Mekong	B-CATLMB50
	B-RIV50
India	River Basin Atlas of India
Thailand	Catalogue of Rivers For Southeast Asia and The Pacific-Volume I-V
	Thailand—Hydrogeologic Map
Indonesia	Catalogue of Rivers For Southeast Asia and The Pacific-Volume I-V
Malaysia	Catalogue of Rivers For Southeast Asia and The Pacific-Volume I-V
Papua New Guinea	Catalogue of Rivers For Southeast Asia and The Pacific-Volume I-V
Philippines	Catalogue of Rivers For Southeast Asia and The Pacific-Volume I-V
Laos	Lao geographic Atlas
Pakistan	Geohydrology of the Indus River,
	Water Resource development projects and Indus basin irridation system
	The new Oxford atlas for Pakistan
Russia	Soviet Union--River Systems Map
Mongolia	National Atlas of Monglian People's Republic
Nepal	Climatic and Hydrological atlas of Nepal
Bangladesh	Bangladesh--Rivers of Bangladesh
Sri Lanka	Sri Lanka Arjuna's Atlas

GDBD - Basin Map and Attributes -

個別属性 ✕

レイヤ: 〈最上位レイヤ〉

□ as_basins   場所: (3464042.489038 |15443)

フィールド	値
OBJECTID	20438
Shape	Polygon
as_basins.Region_NO	2
as_basins.SubRegion_NO	7
as_basins.Basin_NO	28
as_basins.Pfa_Code	20000000
as_basins.Dwn_Pfa_Code	10000000
as_basins.ASIA_ID	8773
Shape_Length	362999.756391
Shape_Area	2084937375.42229
OBJECTID	8773
as_attributes.Asia_ID	8773
as_attributes.Accum_Area	2084940000
as_attributes.Ave_Elev	34.2024
as_attributes.Ave_Slp	1.33887
as_attributes.Str_Lngth	26094
as_attributes.Ave_Str_Slp	0.038495
as_attributes.Cntry_1	Japan
as_attributes.Cntry_1_Rt	100
as_attributes.Cntry_2	<null>
as_attributes.Cntry_2_Rt	<null>
as_attributes.Cntry_3	<null>
as_attributes.Cntry_3_Rt	<null>
as_attributes.Cntry_4	<null>
as_attributes.Cntry_4_Rt	<null>
as_attributes.Cntry_5	<null>
as_attributes.Cntry_5_Rt	<null>
as_attributes.Pop	647894
as_attributes.Pop_Dnsty	0.000311
as_attributes.LULC_1	25.9135
as_attributes.LULC_2	0
as_attributes.LULC_3	0
as_attributes.LULC_4	0
as_attributes.LULC_5	8.79808
as_attributes.LULC_6	37.1154
as_attributes.LULC_7	0
as_attributes.LULC_8	0.048077
as_attributes.LULC_9	0
as_attributes.LULC_10	0.048077
as_attributes.LULC_11	0
as_attributes.LULC_12	12.0673
as_attributes.LULC_13	0.480769
as_attributes.LULC_14	3.94231
as_attributes.LULC_15	0
as_attributes.LULC_16	0
as_attributes.LULC_17	11.5865

IDs and Nextdown Basin ID

Geographic

Topographic

Country

Population/ Population Density

Land Use/Cover

● Each po... ...aphic, social information
● The attri... ...browsed by clicking a polygon on GIS

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work.mxd - ArcMap - A

japan.mxd - ArcMap - A

ファイル(F) 編集(E) 表示(V) 挿

Spatial Analyst ▾   レイヤ: Is

Terrain Preprocessing ▾   Terr

エディタ(R) ▾   ▶   ✎ ▾

ArcToolbox
- 3D Analyst Tools
- Analysis Tools
- Cartography Tools
- Conversion Tools
- Coverage Tools
- Data Management Tools
- Geocoding Tools
- Geostatistical Analyst T
- Linear Referencing Tools
- Spatial Analyst Tools
  - オーバーレイ
  - サーフェス
  - ジェネラライズ
  - ゾーン
    - クロス集計 (Tabula
    - ゾーン フィル (Zona

お気に入り インデックス 検索

🗀 レイヤ
- ☑ as_basins
- ☐ asia_basins
- ☐ dis1_korea_u3
- ☐ dis1_philip_u3
- ☐ dis1_papua_u3
- ☐ dis1_mal_indn_u3
- ☐ dis1_china_u3_erase
- ☐ dis1_yenisey_u3
- ☐ dis1_tarim_u3
- ☐ dis1_s_e_asia_u3
- ☐ dis1_pakis_u3
- ☐ dis1_ob_u3

Utilities ▾   Help   Batch Terrain Preprocessing ▾   Help

トポロジ:

2943625.89 179275.38 メートル

GBDB - general information and status of development -
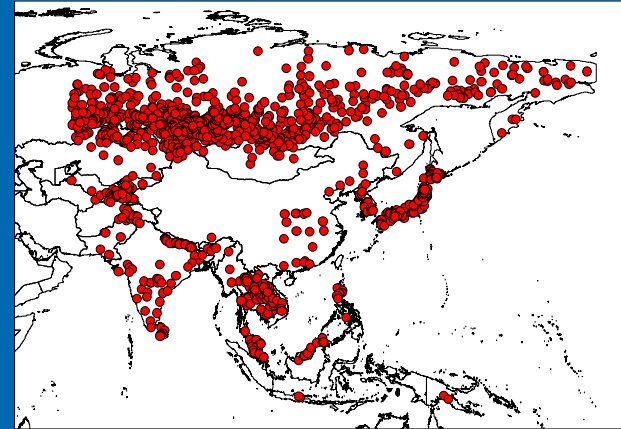
- ➤ general information
  - **Format**: ArcGIS Geodatabase Format
    = ArcGIS + Microsoft Access
    - We can use query, VBA, and so on…
  - **Regions**: 6 regions
    - Africa, Asia-Pacific, Europe+ Central East, North and Central America, Oceania, South America
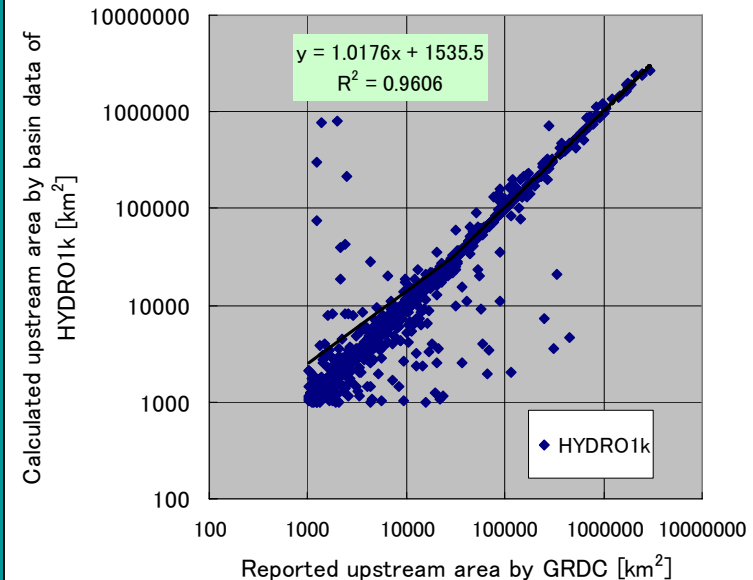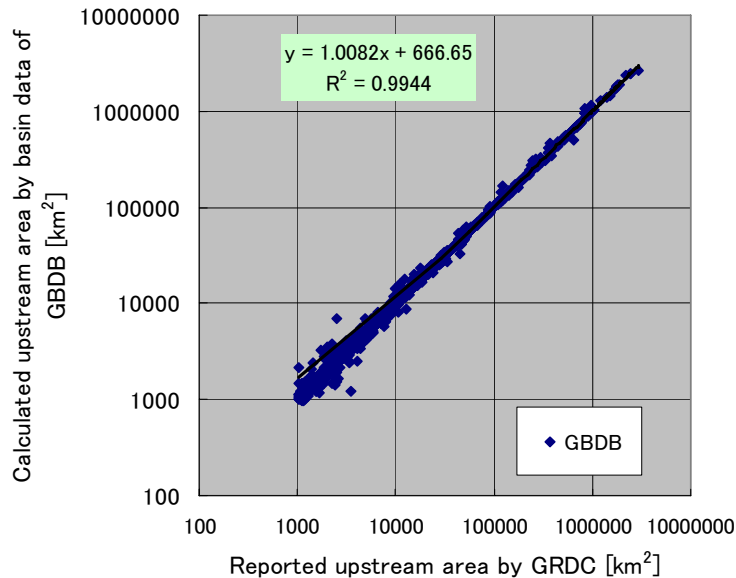- ➤ Status of development
  - For Asia and Pacific region, basins database has been completed
  - For the other regions, basin delineation has been finished once and now we are checking the generated basin data

Validation I - upstream area of discharge gauging station of GRDC -

- ➤ Comparison the calculated upstream area in the basin data of GBDB with the reported ones by GRDC
- ➤ selected 1231 gauging stations from 1383 ones in Asia
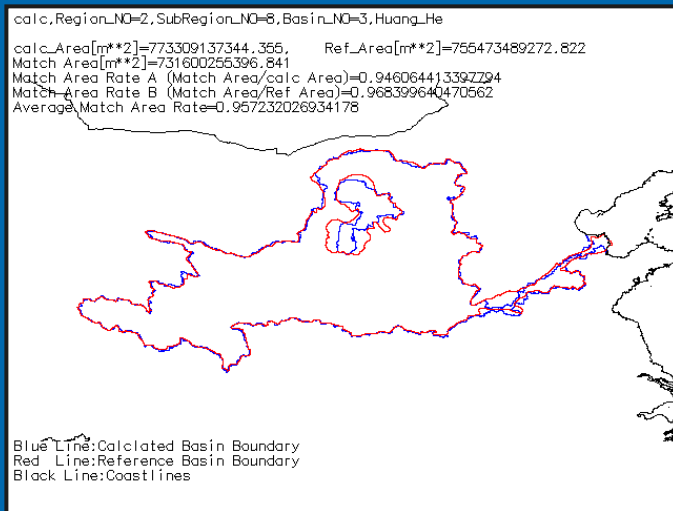 - The omitted stations have clearly wrong value of upstream area or location.

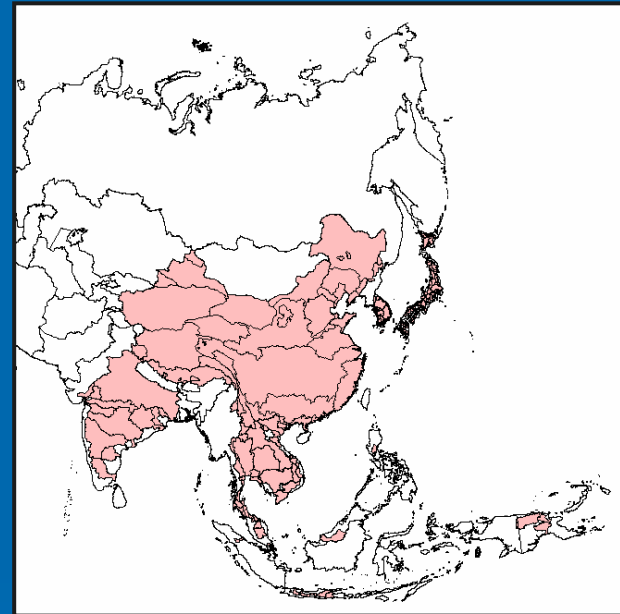Distribution of discharge gauging stations

$y = 1.0082x + 666.65$
$R^2 = 0.9944$

Calculated upstream area by basin data of GBDB [km^2]

Reported upstream area by GRDC [km^2]

GBDB

$y = 1.0176x + 1535.5$
$R^2 = 0.9606$

Calculated upstream area by basin data of HYDRO1k [km^2]

Reported upstream area by GRDC [km^2]

HYDRO1k

Validation Ⅱ-1
- collected basin maps -

➢ Geographical comparison basins data of GBDB with collected digital and paper basin maps

➢ 176 basins in Asia


```
calc,Region_NO=2,SubRegion_NO=8,Basin_NO=3,Huang_He

calc_Area[m**2]=773309137344.355,    Ref_Area[m**2]=755473489272.822
Match Area[m**2]=731600255396.841
Match Area Rate A (Match Area/calc Area)=0.946064413397294
Match Area Rate B (Match Area/Ref Area)=0.968399640470562
Average Match Area Rate=0.957232026934178
```

```
Blue Line:Calclated Basin Boundary
Red  Line:Reference Basin Boundary
Black Line:Coastlines
```


➢ *Average Match Area Rate* (*AMAR*) is introduced in order to evaluate geographical agreement

$$AMAR = (MA/CA+MA/RA)*0.5$$

The nearer to 1 *AMAR* is, the better geographical agreement

- *MA/CA* is the ratio of geographical agreement area to area of a basin of GBDB
- *MA/RA* is the ratio of geographical agreement area to area of a basin of a collected map

Validation Ⅱ-2 　- Result -
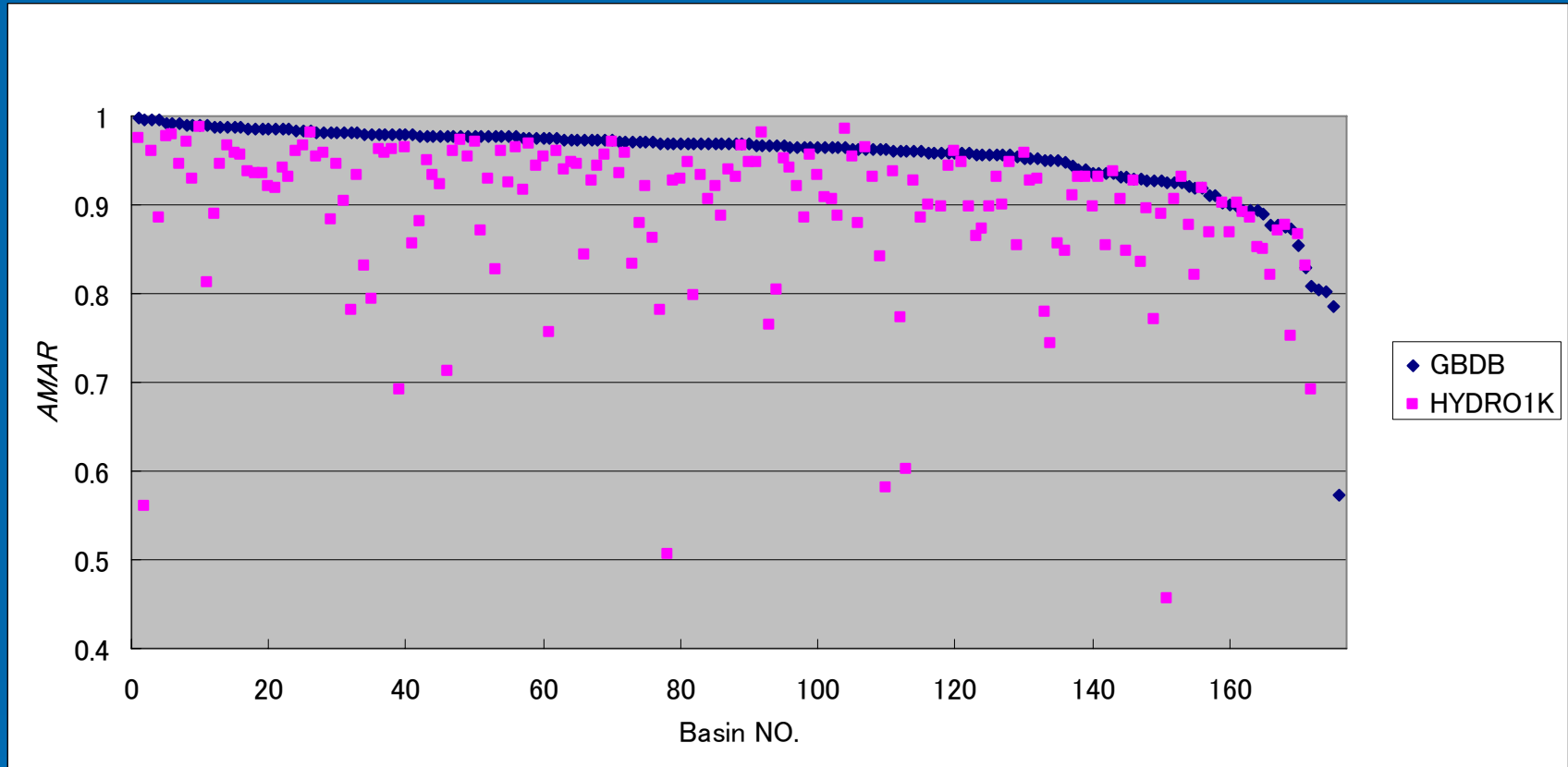
> ➤ Almost all of the basins of GBDB are in good geographical agreement with those of collected maps.

> ➤ The values of AMAR of GBDB are higher than those of collected maps for almost all of the basins
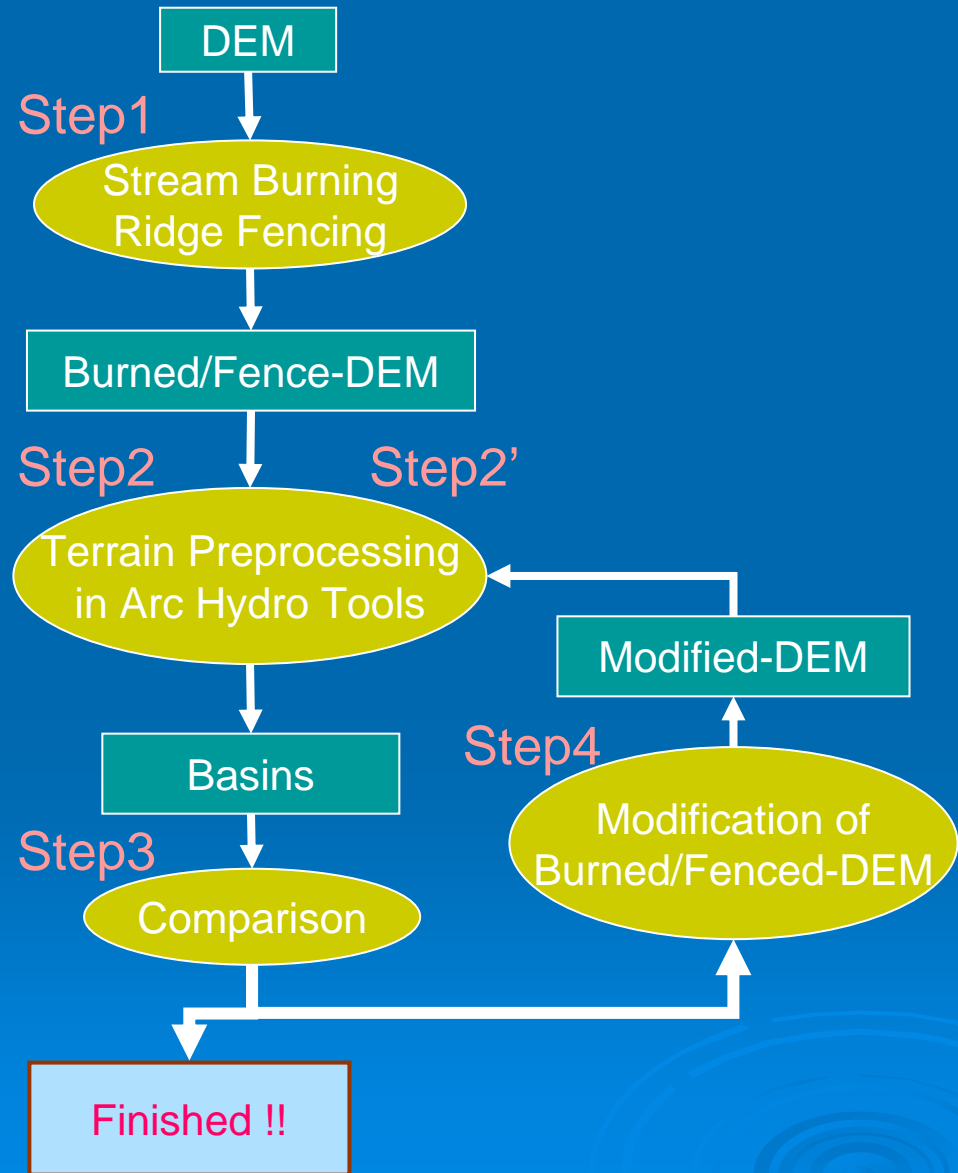
Summary and Future plans

➢ We have developed Global Basins Database (GBDB) in Asia-Pacific region.

➢ The results of validation reveal that the database is reliable.

➢ The database has many attributes which are useful in modeling, assessment, and management.

➢ Now we are still developing for the other region.

➢ The output will be distributed in the web of the Center of Global Environmental Research (CGER) soon.

➢ I am preparing for using the GBDB in hydrological modeling.

➢ If you have basin map of your country, Please give me it!

# Methodology

DEM

Step1

Stream Burning
Ridge Fencing

Burned/Fence-DEM

Step2   **Step2'**

Terrain Preprocessing
in Arc Hydro Tools

Modified-DEM

Basins

Step4

Modification of
Burned/Fenced-DEM

Step3

Comparison

Finished !!

Step1: Stream Burning/ Ridge Fencing

Stream Burning:
Ridge Fencing:DEM(Digital
Eleation Model)
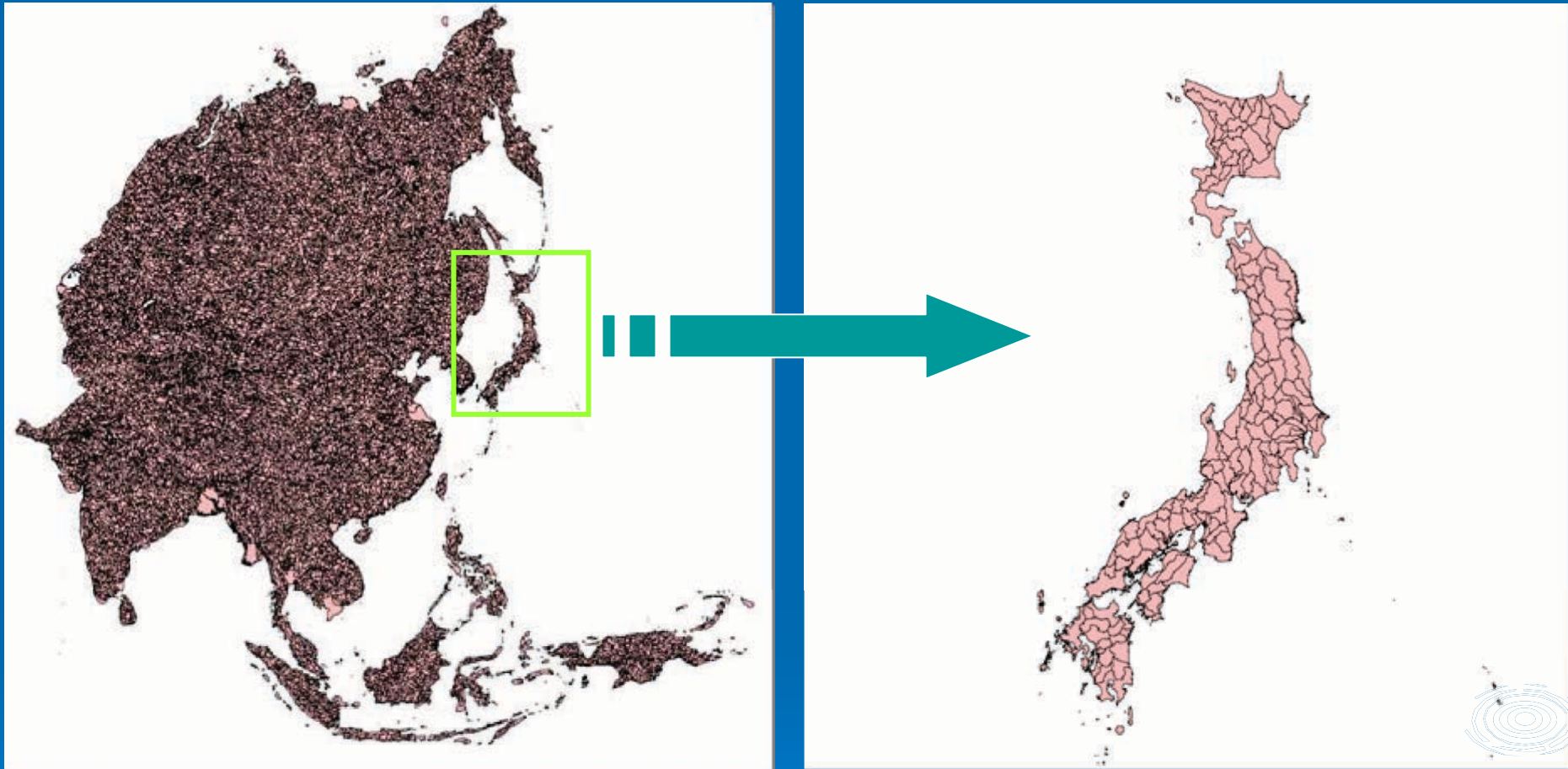
Input DEM

Region	DEM
Japan	250m-DEM
Korean Peninsula	3sec-DEM
Other regions	1km-DEM

GBDB – Basins Map -
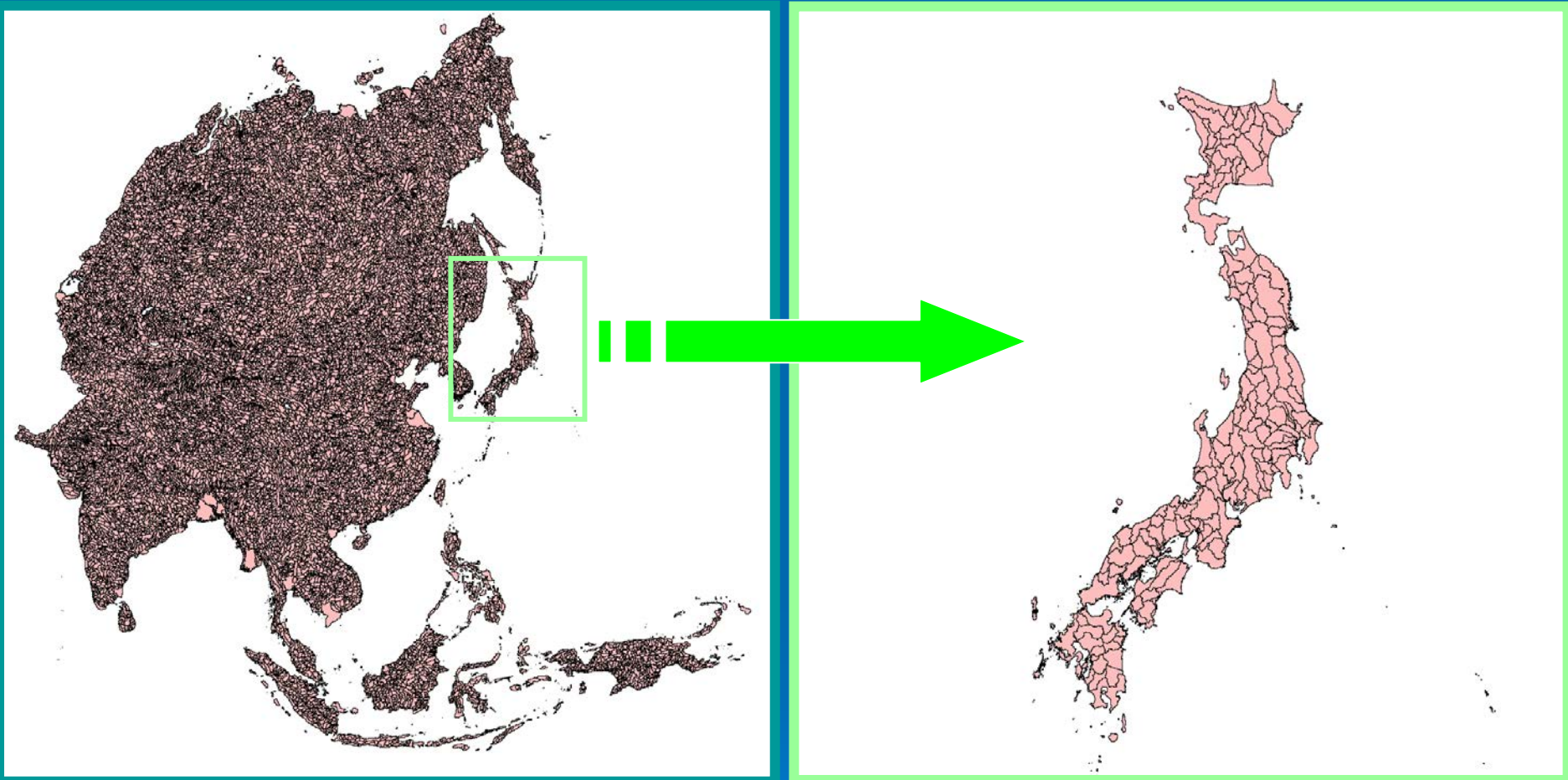
➢ Each polygon has geographic, topographic, social information
  ● The attributes of each polygon can be browsed by clicking a polygon on GIS

What is GBDB?-basic-

> GBDB consists of polygons which are elementary drainage areas
> Each polygon has geographic, topographic, and social information