Introduction to AIM/Impact model
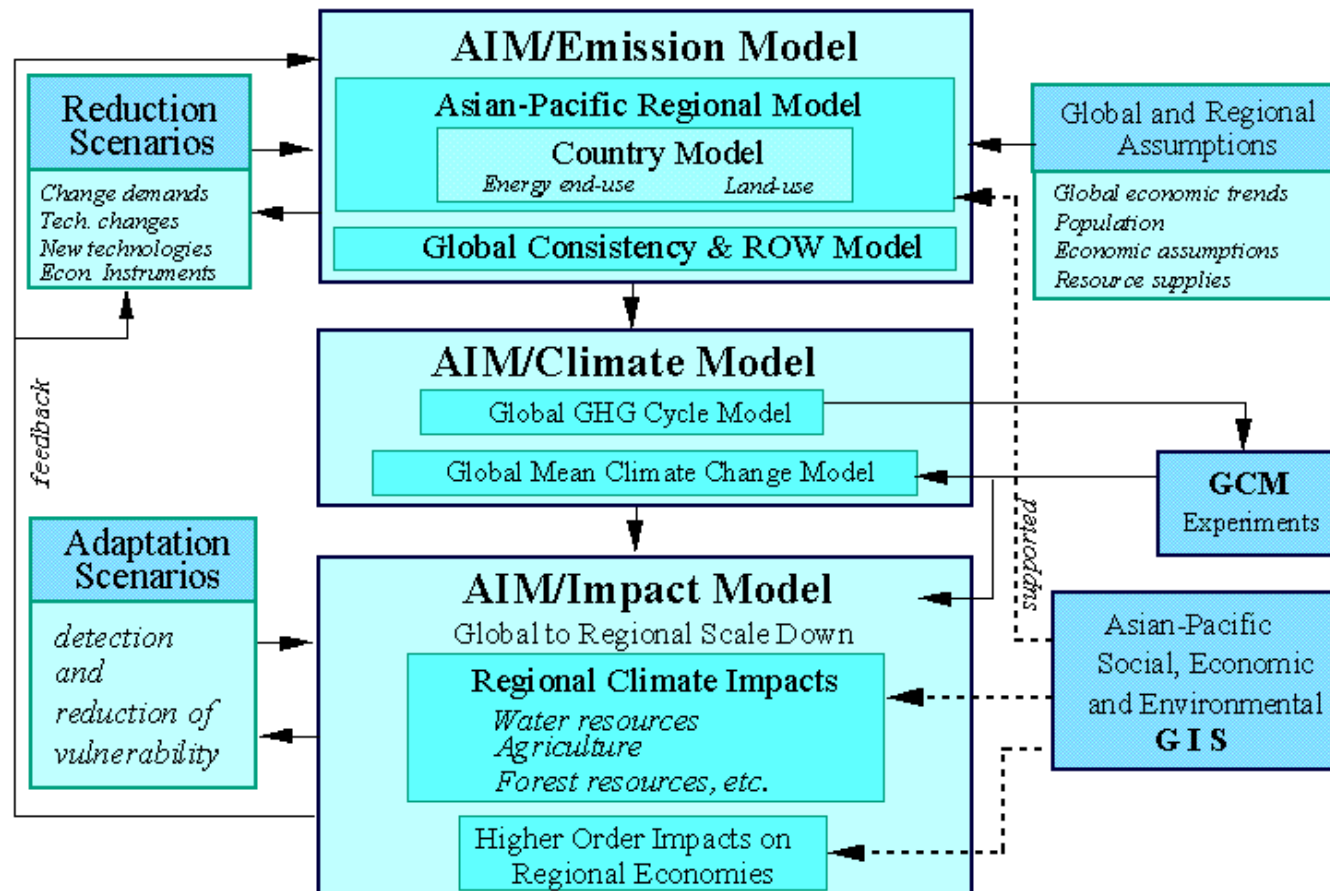
Kiyoshi Takahashi

National Institute for
Environmental Studies

Items of the presentation

- Overview of AIM/Impact model
  - Structure
  - Examples of the assessed results
- Introduction to AIM/Impact [Country]
  - Structure, Objective
 - Current status of development

AIM/Impact in AIM Framework

Objective of AIM/Impact

- Projection of potential impacts of climate change on sensitive sectors.
- Consideration of linkages among affected sectors.
- Proposition of effective adaptation measures to cope with climate change.
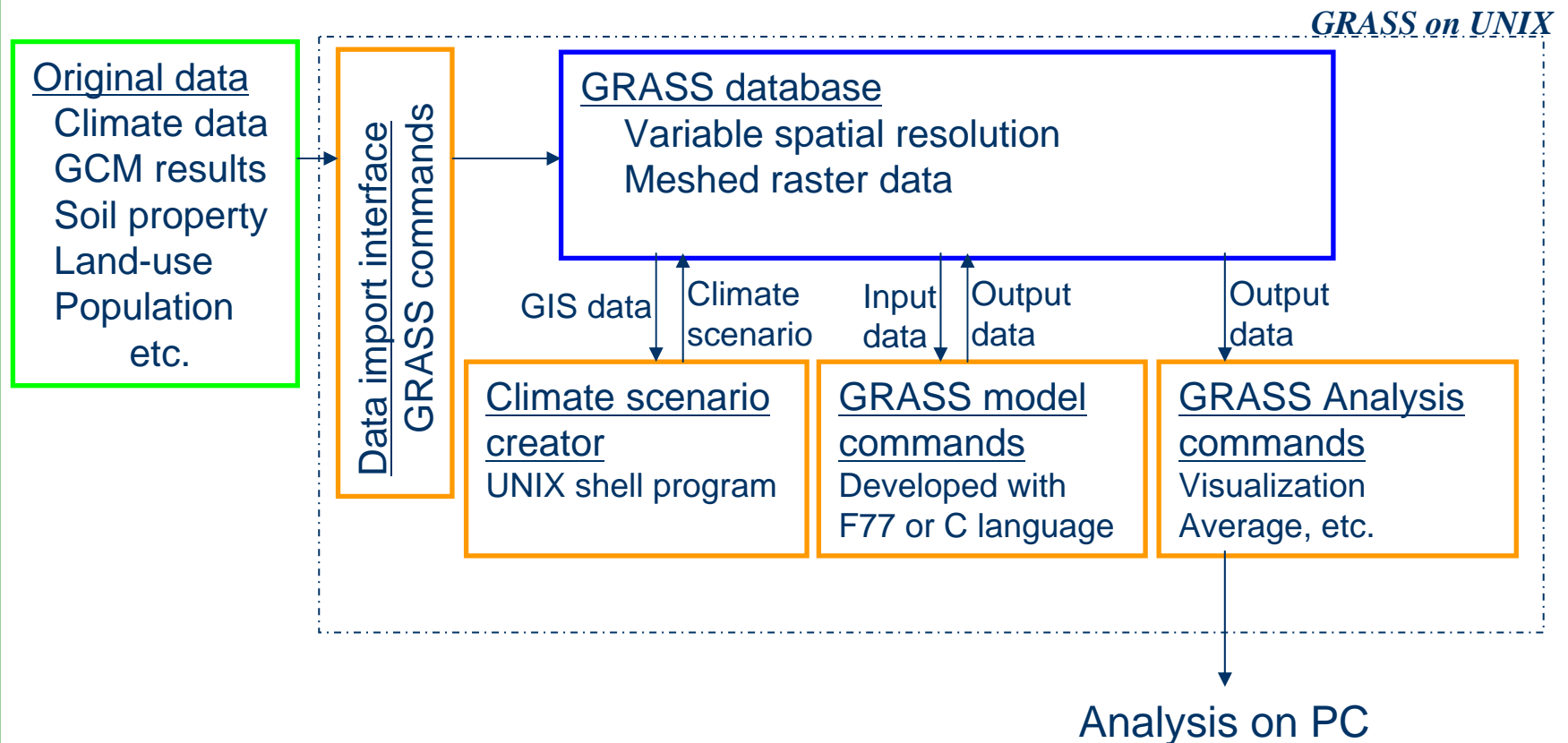- Accounting feedback effects on GHGs concentration and climate system.

Framework of the AIM/Impact model
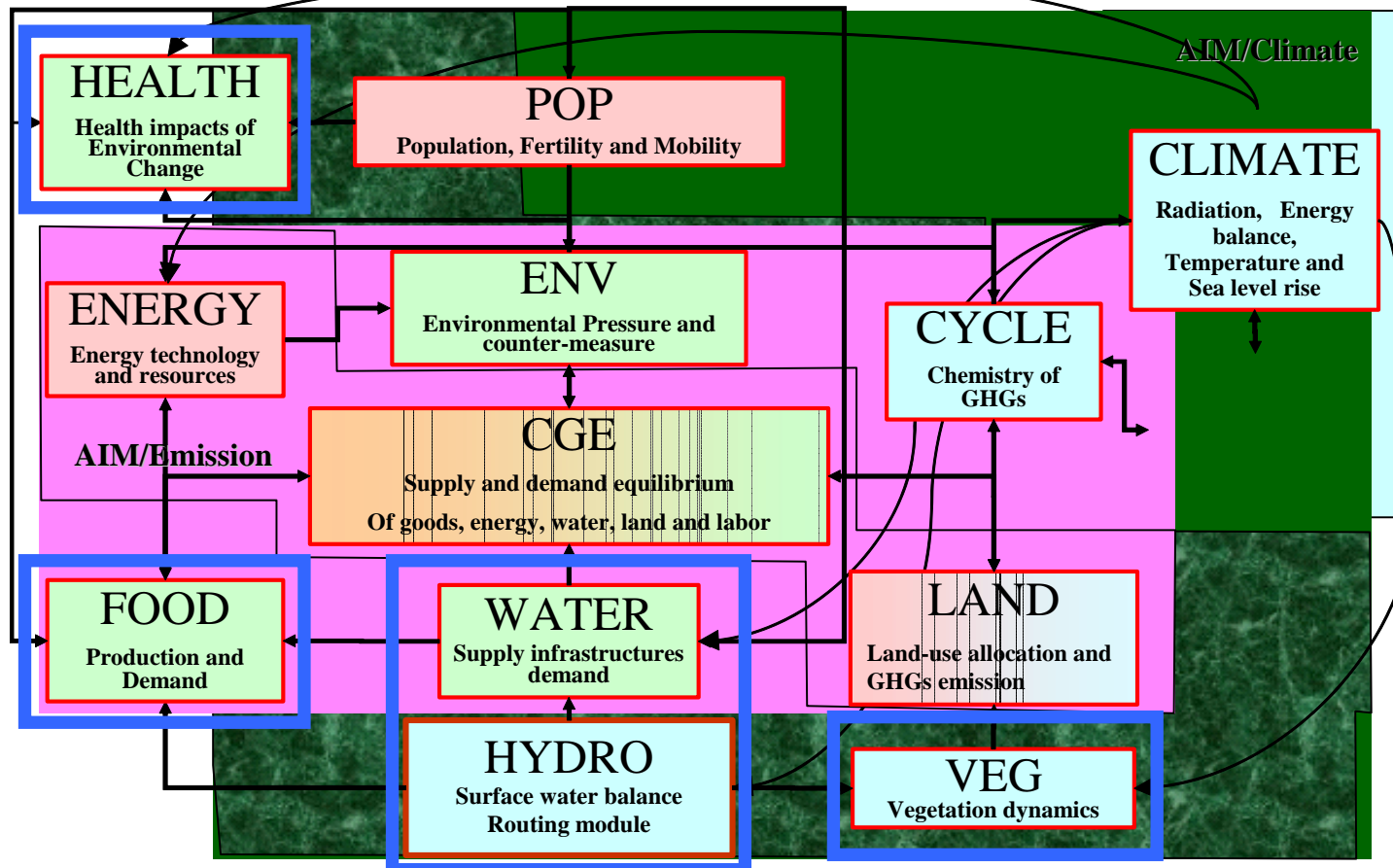
Characteristics of AIM/Impact

- Area focused: Whole Asia to Global
- Spatial analysis (Modules run on GIS)
- Consistency between socio-economic scenario and climate change scenario.
- Integration of emission (WG3), climate (WG1) and impact and adaptation (WG2) in the institute.

Computation framework

Collaboration with climate model

Emission model

A1 高成長社会　A2 多元化社会

B1 持続発展型社会　B2 地域共存型社会

{ 社会発展シナリオ 排出削減対策シナリオ

AIM (Asian-Pacific Integrated Model)

Socio-Econ. & Emission Scenario

Climate model

CCSR/NIES CGCM

Atmosphere 大気モデル

Ocean 海洋モデル

Land Surface 陸面モデル

Landuse　Water Resource

Socio-Econ. Factors　Crop Productivity

Food Demand And Supply

Impact model

Adaptation

Simplified framework

Climate data   GCM outputs   Global average temperature increase

Climate module

Future climate change

Water balance module

Water resource module   Water demand module

Water scarcity evaluation

Water impact

Socio-economic scenario

Crop productivity module

Global trade module

Agricultural impact

Natural ecosystem module

Health impact module

Crop productivity

Climate data
Temperature
Precipitation
Radiation
Wind
Humidity

Soil data
Chemical characteristics
Slope
Texture

Human Input
Irrigation
Machinery
Fertilizer

−500   0   +500   (kg/ha)

Changes in the potential productivity of rice
from 1990 to 2050 under the climatic conditions
projected using the CCSR/NIES GCM

Agricultural trade

	JPN	CHN	IDI	CAN	USA	E_U
Producer price change (%)						
Rice	-0.01	-1.58	17.96	-40.16	-0.06	-4.93
Wheat	4.91	8.47	125.11	-13.10	4.76	8.92
Other grains	1.81	0.7			-1.46	-3.36
Other crops	-0.01	-0.28	1.90	2.76	-0.10	-0.05
Livestock	-0.19	-0.09	2.84	-1.22	-0.59	-0.04
Other agricultural products		-0.01			.07	0.04
Manufacture	0.03	-0.12	-1.10	0.61	0.03	-0.02
Services	0.03	-0.16	0.93	0.69	0.02	-0.02
Production change (%)						
Rice	0.11	-0.25	-1.76	105.99	0.23	2.03
Wheat		-3.97				-3.64
Other grains	-15.56	-1.39	1.33	89.41	-4.04	-6.50
Other crops	0.11	-0.07	-4.25	-2.26	0.25	-0.03
Livestock	0.09	-0.24	-2.27	0.94	0.03	-0.22
Other agricultural products	0.11	-0.27		0.69	0.04	-0.22
Manufacture	-0.01	0.31		-1.62	0.03	0.05
Services	0.00	0.00	-2.62	-0.02	0.01	0.01
Consumer price index (%)	0.001	0.001			0.017	-0.010
Income change per capita (%)	0.026	-0.236		0.853	0.026	-0.009
Social welfare change (%)	0.022	-0.219	-4.892	0.343	0.009	0.003

Production
Crop productivity change
Tech. Improve
Labor
Land

Demand
Population
Consumer preference

Trade
Tariff etc.

River discharge

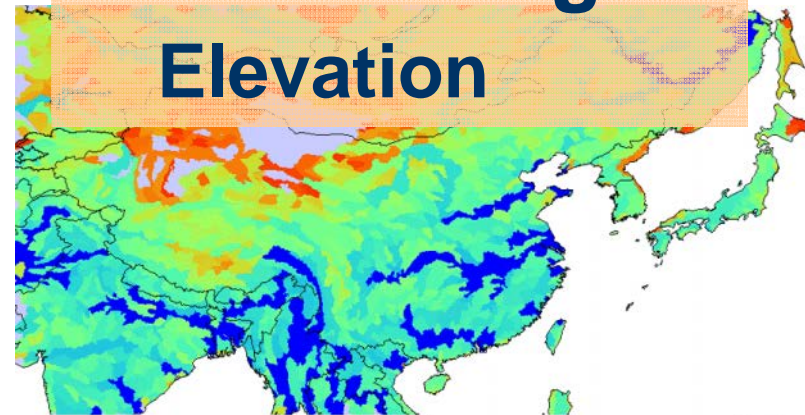
Surface runoff
  Precipitation
  Evaporanspiration
  Temperature
  Soil characteristics

River routing
  Elevation

1990

2100

Annual river discharge in 1990 and 2100 (UIUC climate model)

Water demand (withdrawal)

Driving force

Irrigated area

Population

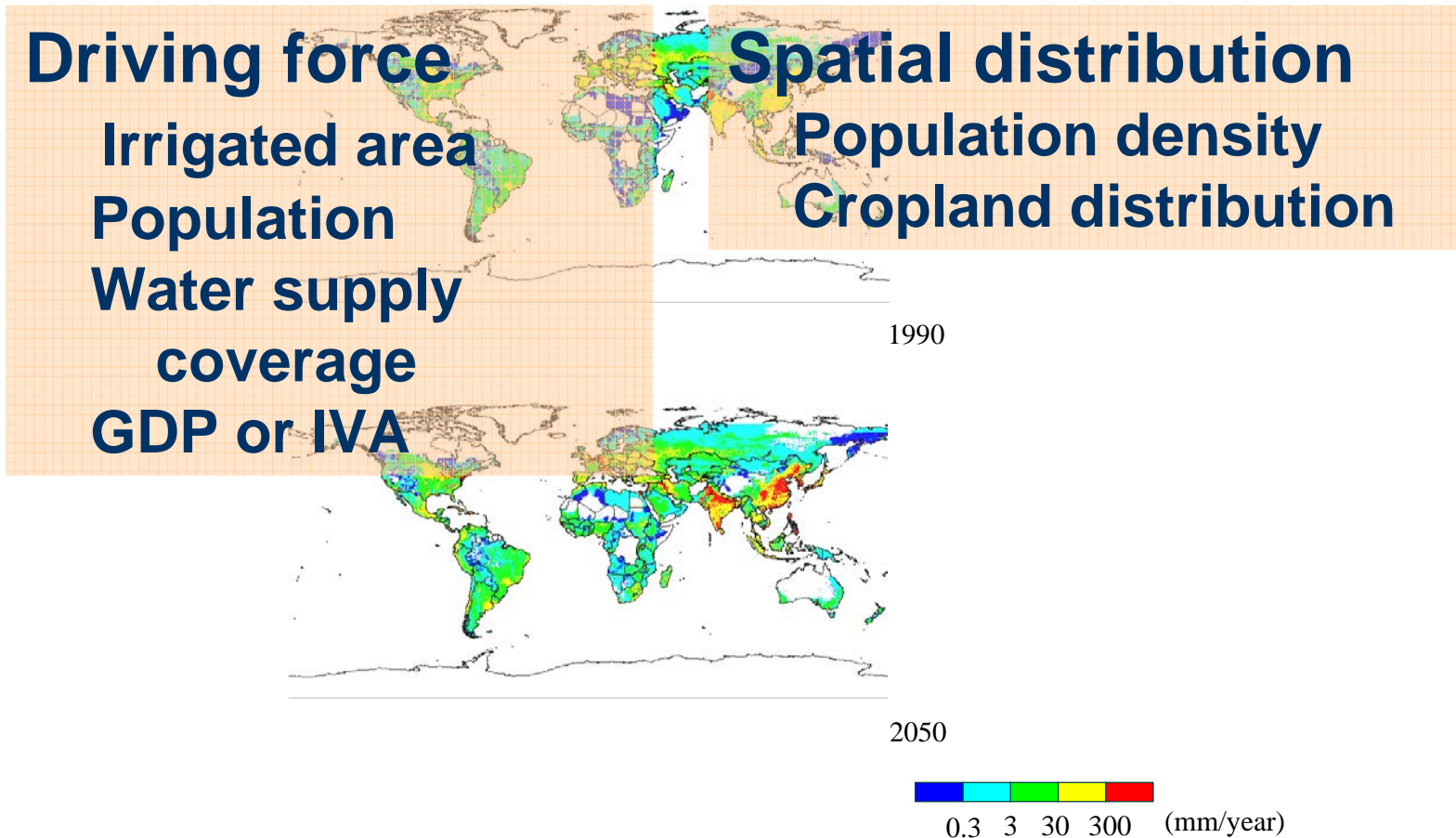Water supply coverage

GDP or IVA

Spatial distribution

Population density

Cropland distribution

1990

2050

0.3   3   30   300   (mm/year)

Water consumption in India (scenario analysis)

1995
Baseline

2032
Fortress World

2032
Policy Reform
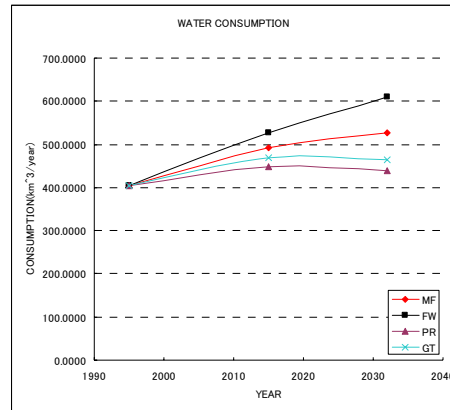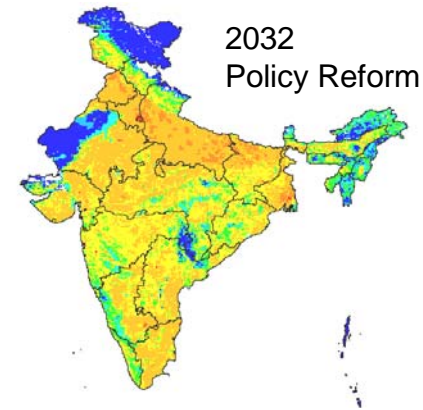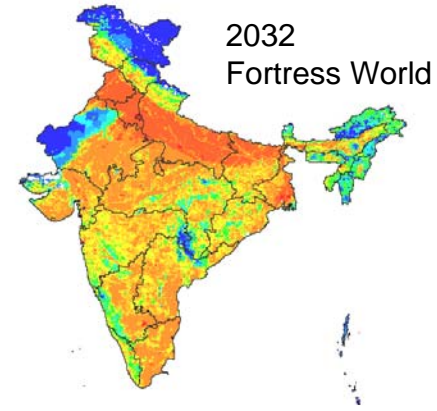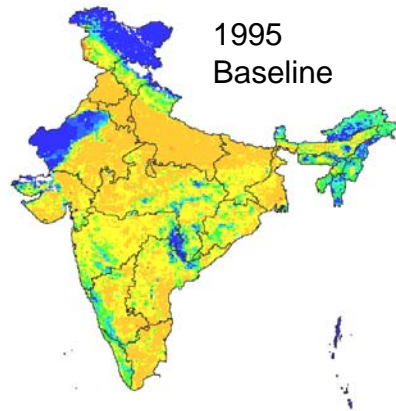
WATER CONSUMPTION

Change of water consumption from 1995 to 2032
(Domestic + Agriculture + Industry)

m^3/ha/year

1   40   200   1000   5000
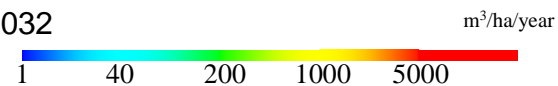
Surface runoff as Water supply

Evapotranspiration
  Temperature
  Wind speed
  Radiation
  Humidity

CCCma

MPI

Field capacity
  Vegetation
  Soil

NIES

Change of surface runoff
(2050s – 1980s)

-100 -10 0 10 100 (mm/year)
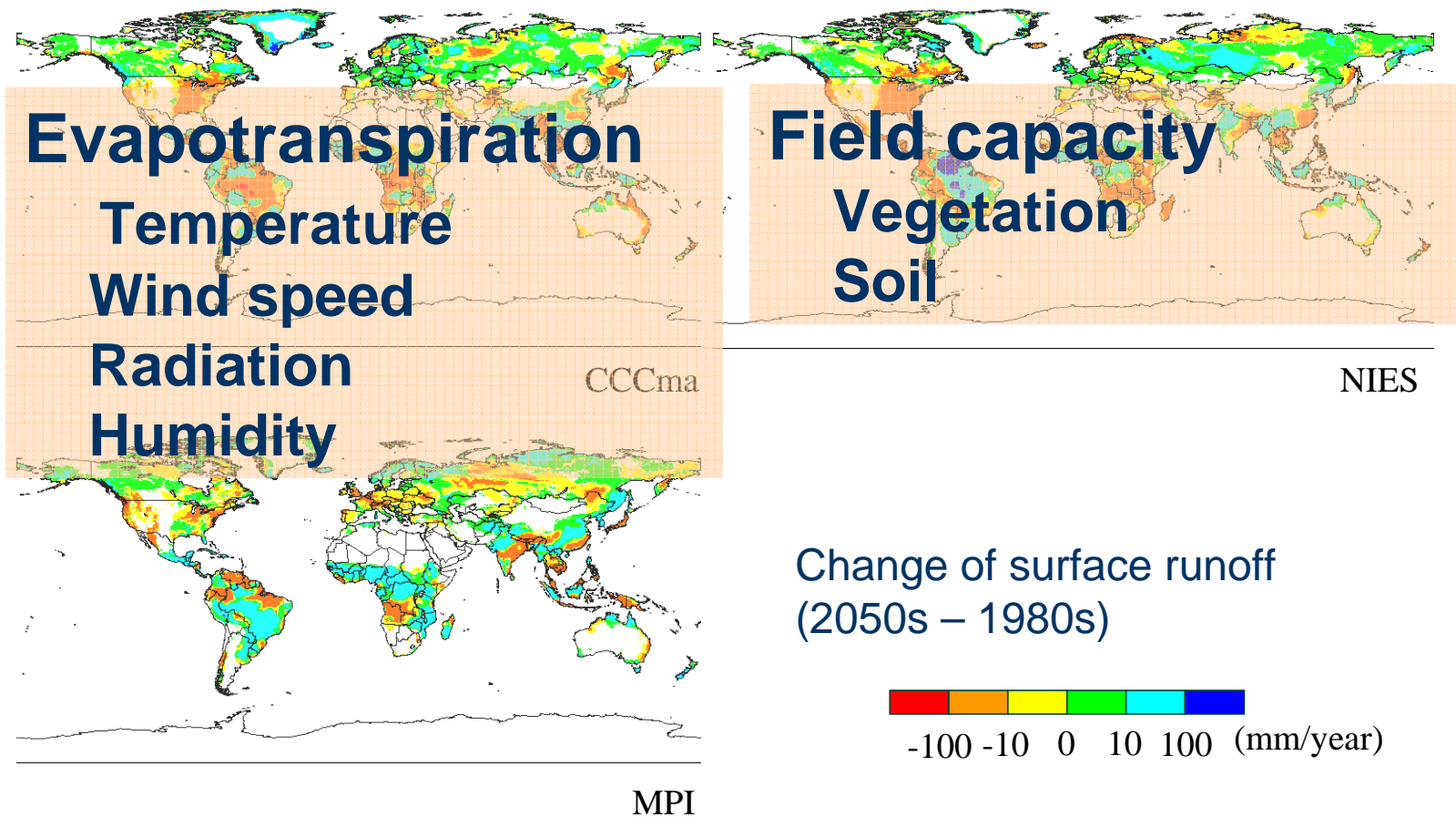
River basin for water scarcity assessment
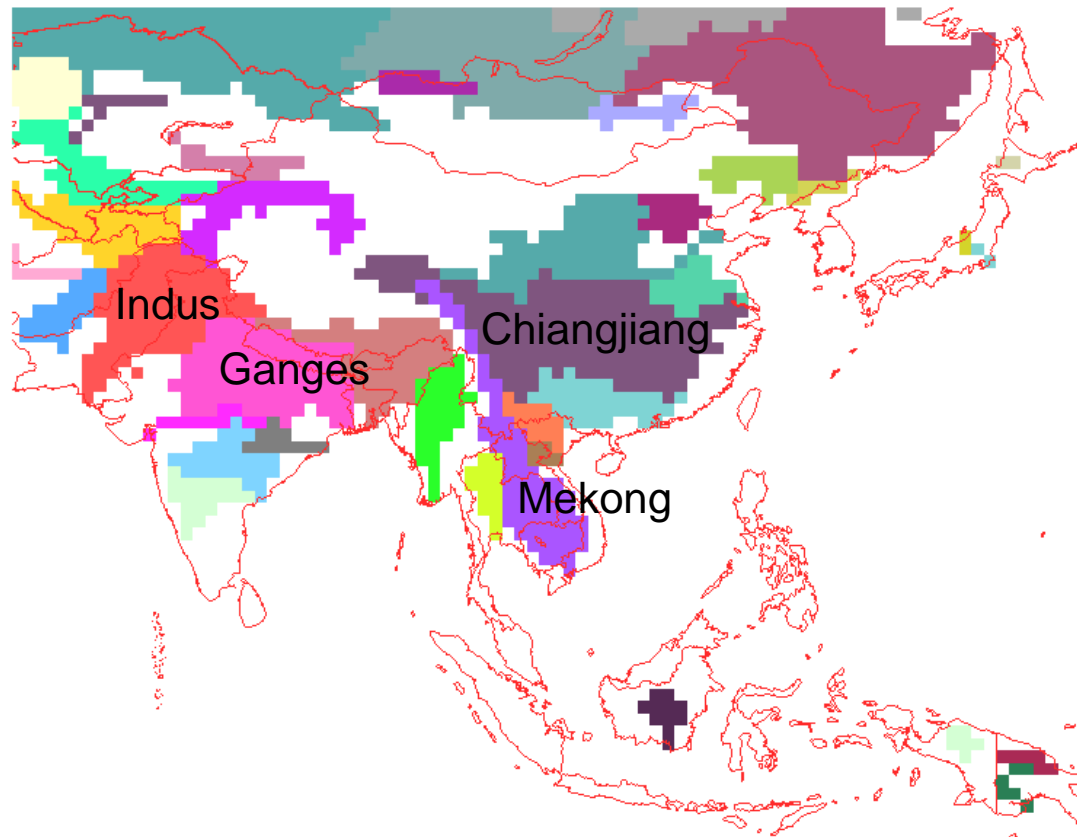
Water scarcity

Scarcity index = Withdrawal / Surface runoff
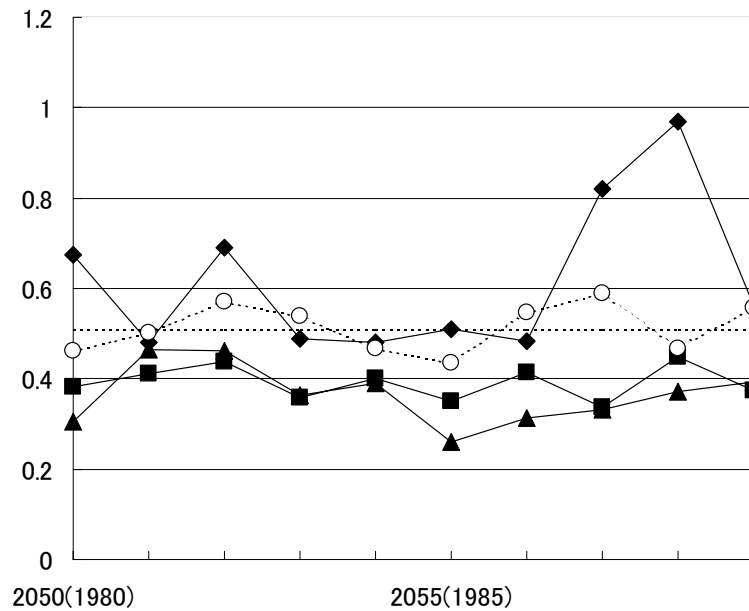
Ganges
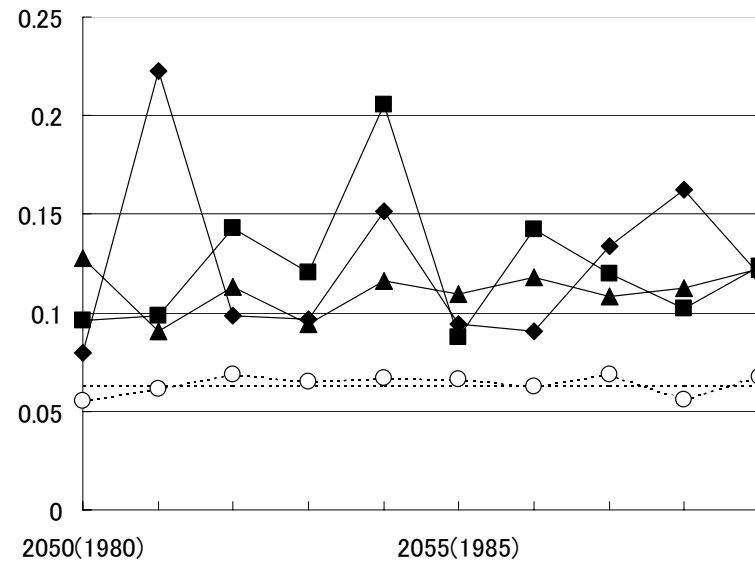
Mekong

- ■ CCC
- ▲ ECHAM4
- ◆ CCSR/NIES
- ⊙ LINK (1980-89)
- Ten-year average (1980-89)

Malaria

Reproduction rate of malaria vector
 Temperature
 Soil moisture

2 x CO2

1 x CO2

low receptivity   endemic
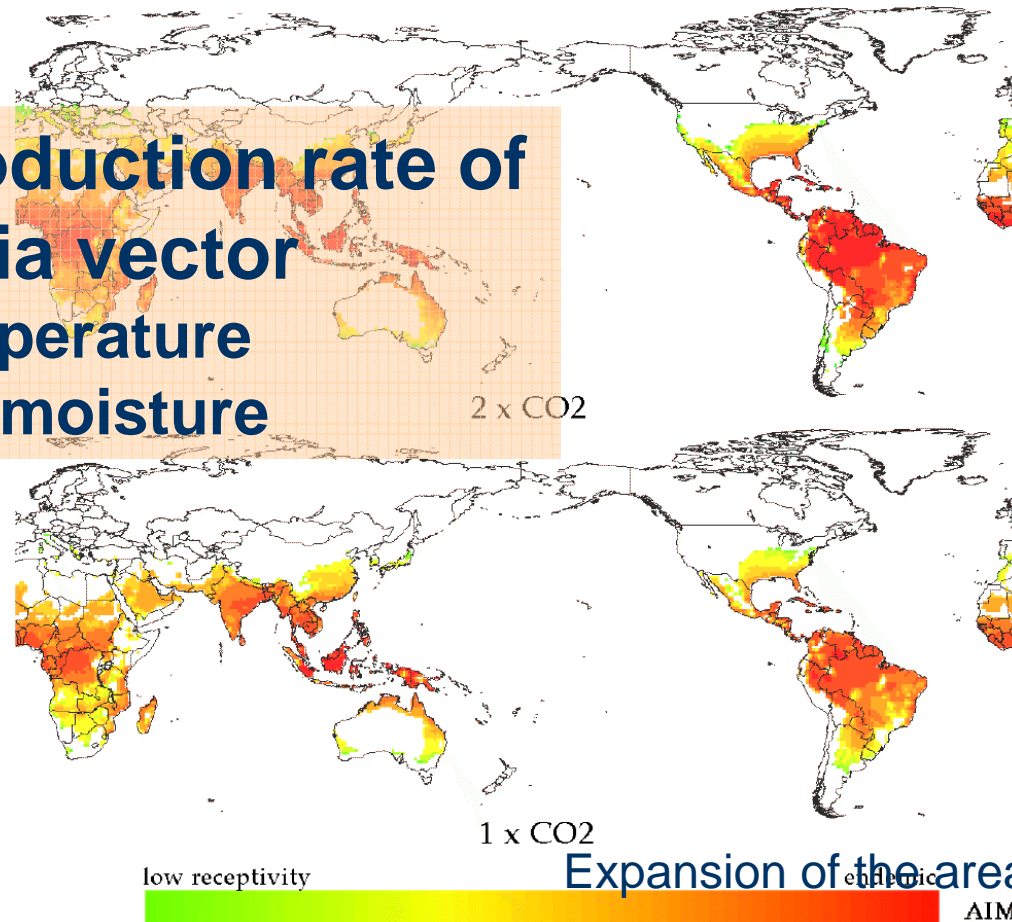
Expansion of the area affected by malaria

AIM

Diarrhea

Diarrhea / capita
Water supply coverage
Temperature

Water supply coverage
GDP/capita
Environmental consideration
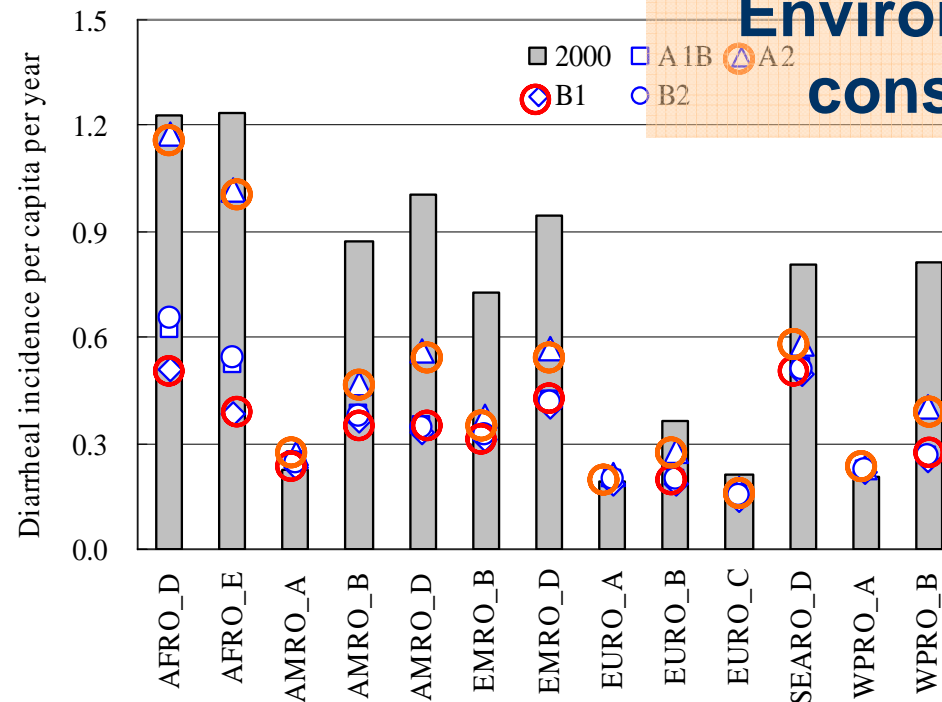
Diarrhea incidence per capita per year in 2000 (bar graph) and in 2055 for 4 SRES scenarios (□A1B,△A2,◇B1,○ B2).

Forest vegetation

Forest diminishment
  Temperature
  Precipitation
  Evapotranspiration
  Max. velocity of
     forest movement
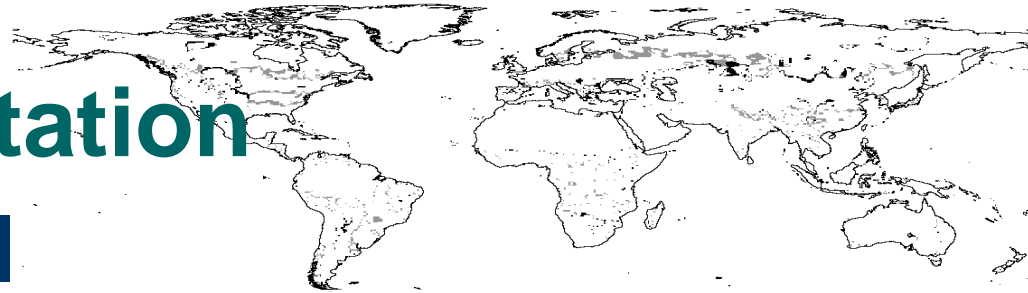
IS92c scenario with low climate sensitivity
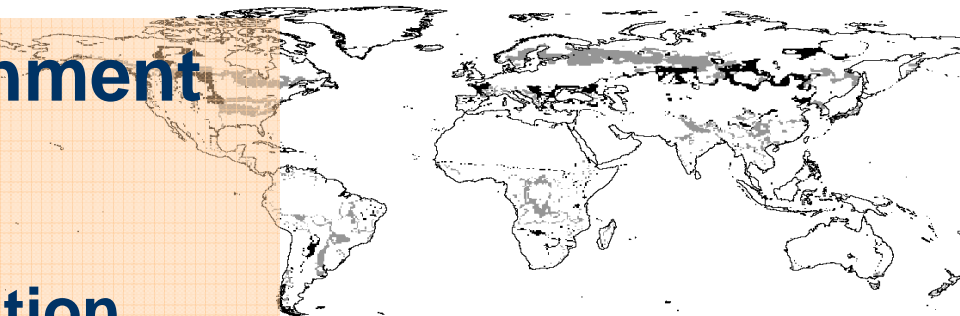
IS92a scenario with medium climate sensitivity
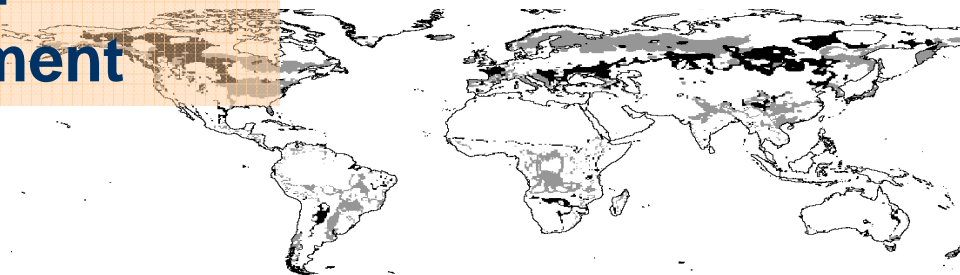
IS92e scenario with high climate sensitivity

Diminishment of forest

Replacement of forest type with the risk of diminishment

From global scale to national scale

- Increasing attention to national-scale impact studies.
  - AIACC (Assessment of the Impact of and Adaptation to Climate Change Project)
  - National Communication
- Concrete adaptation measures can be evaluated only on an appropriate spatial scale which corresponds the stakeholders.

Features of AIM/Impact [Country]

- Package of models, tools and data for scenario analysis of national-scale climate change impact assessment.
- Executable on PC-Windows (no need to learn UNIX & GRASS)
- Bundled datasets for basic assessment.
- Readily achievement of spatial analysis.
- Detailed manual documents.

Framework of AIM/Impact [Country]

(1) Development of input GIS data for model

Global GIS data → **GIS data trimmed for national scale assessment** → **Input GIS data for impact assessment models**

Model parameters

(2) Impact assessment

GIS tool for trimming away ex-focused area
GIS tool for spatial interpolation

GIS tool for input data development (Scenario Creator)

Socio-economic and GHG emission scenarios

Penman-PET model
Thornthwaite-PET model
Potential crop productivity model
Surface runoff model
River discharge model
Water demand model
Malarial potential model
Holdridge vegetation classification
Koeppen vegetation classification
Vegetation move possibility model

(3) Analysis of GIS data and outputs

Output GIS data of impact assessment model

Interface tool for visualizing data on plain spatial data viewer
Interface tool for visualizing data on IDRIDI

GIS tool for sub-national aggregation

GIS data for sub-national spatial aggregation

PREF.ID	NAT	REG	PREF	VALUE
392010100	JPN	Hokkaido	Hokkaido	12
392020100	JPN	Tohoku	Aomori	−10
392020400	JPN	Tohoku	Akita	−5
392020200	JPN	Tohoku	Iwate	−5
392020400	JPN	Tohoku	Akita	2
392020500	JPN	Tohoku	Yamagata	3
392020300	JPN	Tohoku	Miyagi	−13
392040100	JPN	Hokuriku	Niigata	−2
392020600	JPN	Tohoku	Fukushima	8
392040300	JPN	Hokuriku	Ishikawa	−6
392030200	JPN	Kanto	Tochigi	−7
392030300	JPN	Kanto	Gumma	15
392050200	JPN	Chubu	Nagano	17
392040200	JPN	Hokuriku	Toyama	12
392030100	JPN	Kanto	Ibaraki	−1

Development of input GIS data for impact assessment models

Global GIS data

Ready-made global GIS data

- Observed climate (LINK)
- GCM results (IPCC-DDC)
- Soil (DSMW, FAO)
- Population (NGCIA)
- Cropland and Irrigated land

Originally imported global GIS data

- Additional GCM results
- Observed climate from other data sources

GIS tool for trimming away ex-focused area
GIS tool for spatial interpolation

GIS data trimmed for national scale assessment

Originally imported GIS data trimmed at focused area

- Regional climate model results
- Region-specific soil data
- Population distribution with finer resolution

GIS tool for input data development (Scenario Creator)

Input GIS data for impact assessment models

Monthly climate：Temperature, Rainfall, Cloudiness, Windspeed

Socio-economic:
Population distribution
Cropland / Irrigated land

Soil:
Soil unit, soil texture, slope, soil phase, field capacity, elevation, albedo

Socio-economic and GHG emission scenarios

GHG emission scenarios

Change of annual mean global temperature

Scenarios of population change and other socio-economic factors

A1	A2
B1	B2

- Originally imported data
- Ready-made data bundled in the package
- Tools and Models

Impact assessment models

Input GIS data for impact assessment models

Monthly climate：
Temperature, Rainfall,
Cloudiness, Windspeed

Socio-economic:
Population distribution
Cropland / Irrigated
land

Soil:
Soil unit, soil texture,
slope, soil phase, field
capacity, elevation,
albedo

Penman-PET model
Thornthwaite-PET model
Potential crop productivity model
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River discharge model
Water demand model
Malarial potential model
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Koeppen vegetation classification
Vegetation move possibility model

Output GIS data of impact assessment model

Penman-PET
Thornthwaite-PET
Potential crop productivity
Surface runoff
River discharge
Water demand
Malarial potential
Holdridge vegetation classification
Koeppen vegetation classification
Vegetation move possibility

Model parameters

Characteristics of crop growth
Soil constraints on crop production
Snow melt temperature
Rate of water discharge in river
Potential rate of vegetation move

Ready-made   Originally imported

Analysis of GIS data and outputs

Output GIS data of impact assessment model

Penman-PET
Thornthwaite-PET
Potential crop productivity
Surface runoff
River discharge
Water demand
Malarial potential
Holdridge vegetation classification
Koeppen vegetation classification
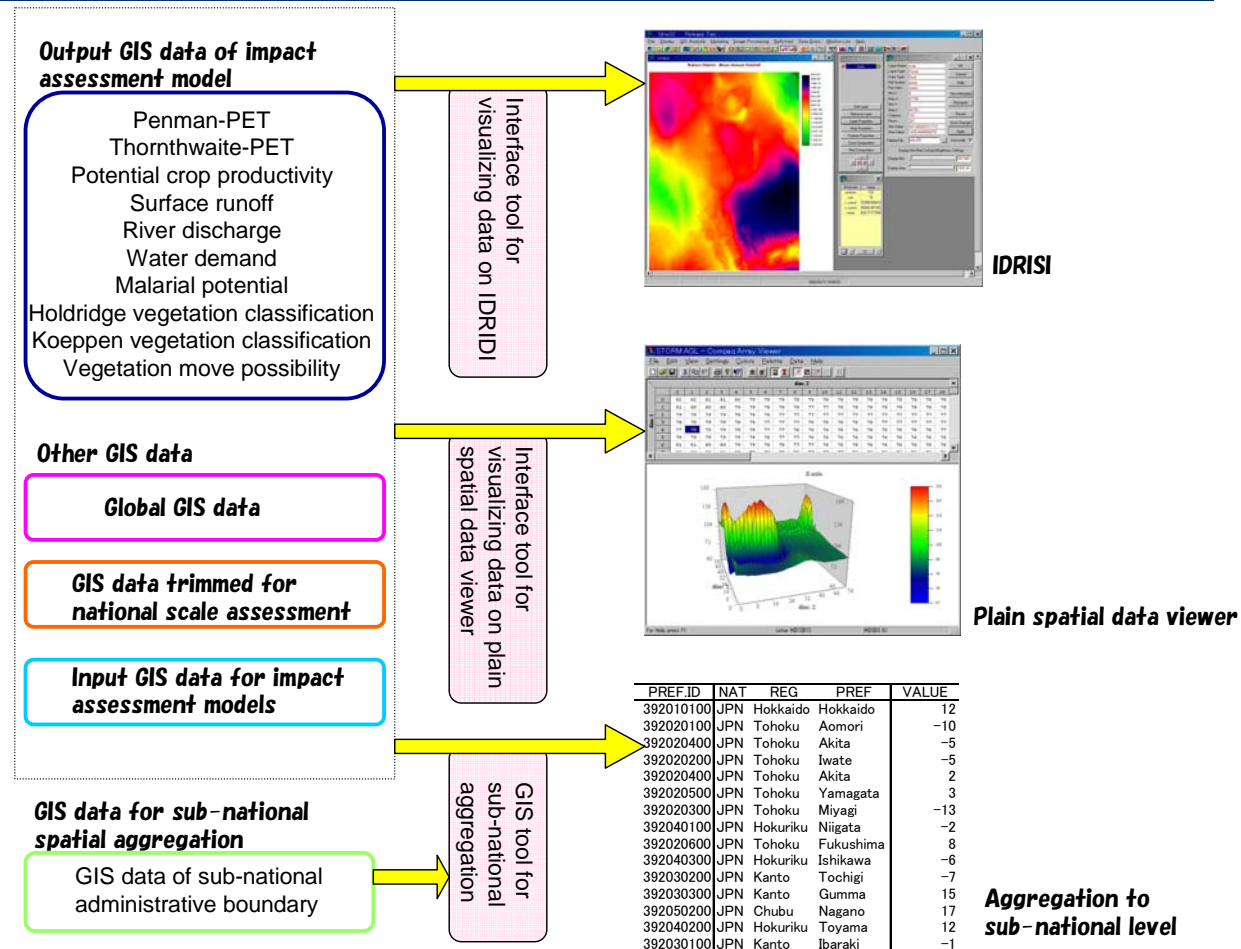Vegetation move possibility

Interface tool for visualizing data on IDRIDI

IDRISI

Other GIS data

Global GIS data

GIS data trimmed for national scale assessment

Input GIS data for impact assessment models

Interface tool for visualizing data on plain spatial data viewer

Plain spatial data viewer

GIS data for sub-national spatial aggregation

GIS data of sub-national administrative boundary

GIS tool for sub-national aggregation

PREF.ID	NAT	REG	PREF	VALUE
392010100	JPN	Hokkaido	Hokkaido	12
392020100	JPN	Tohoku	Aomori	−10
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392040200	JPN	Hokuriku	Toyama	12
392030100	JPN	Kanto	Ibaraki	−1

Aggregation to sub-national level

Analysis of GIS data and outputs
- Visualization -

- For IDRISI user
  - GIS data in AIM/Impact [Local] will have genuine IDRISI format, and AIM/Impact [country] visualize the data with starting up IDRISI through IDRISI-API functions.
  - Full IDRISI functions can be used to process and analyze the GIS data in AIM/Impact [Local].
- For Non IDRISI user
  - Plain spatial data viewer software (COMPAC FORTRAN Array Visualizer) is included in the package, and user can see and print out the results visually.
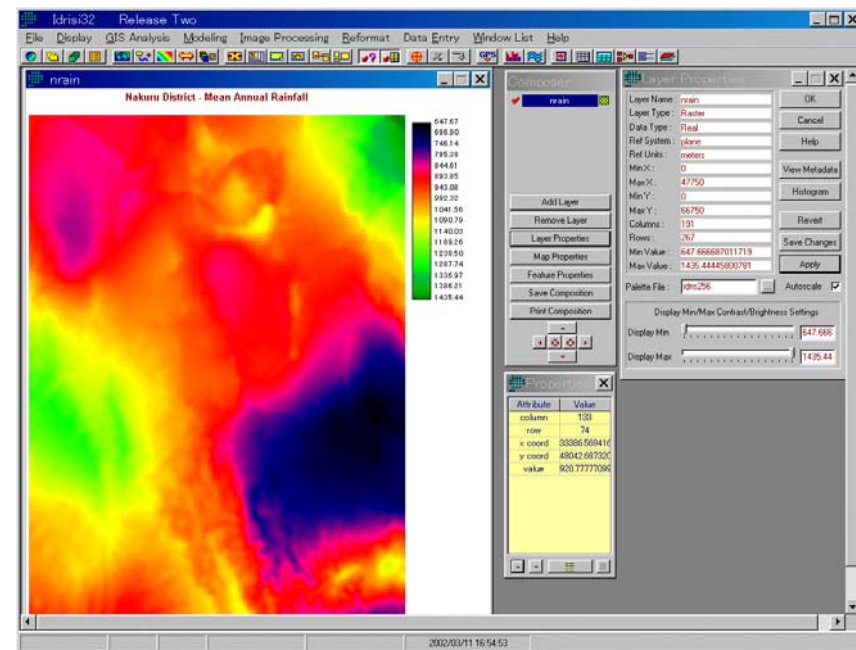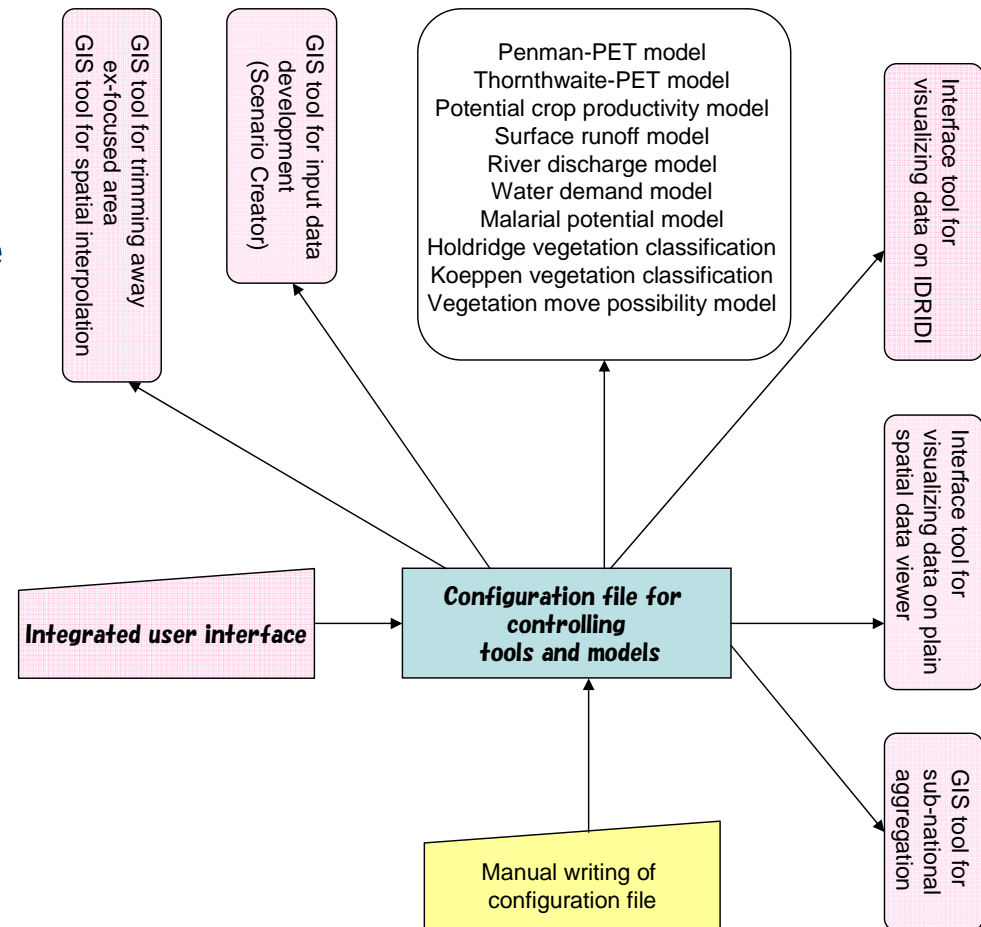
Analysis of GIS data and outputs
- Regional aggregation -

- Numerical grasp of the result with representative values is also important and useful.
- Input GIS data and assessed results of impacts are aggregated spatially and mean values for sub-national divisions are tabulated.
- Ready-made GIS data of sub-national divisions incorporated in the package.

PREF.ID	NAT	REG	PREF	VALUE
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392020100	JPN	Tohoku	Aomori	−10
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392030100	JPN	Kanto	Ibaraki	−1

Integrated user interface of AIM/Impact-country

- User-friendly MS Visual Basic form similar to the AIM-Trend.

- The interface is used to complete a configuration file controlling data management tools, models, visualization tool.

- Configuration file can be edited manually, which enables complicated model simulation with batch programming by expert users.

GIS tool for trimming away ex-focused area
GIS tool for spatial interpolation

GIS tool for input data development (Scenario Creator)

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Interface tool for visualizing data on IDRIDI

Interface tool for visualizing data on plain spatial data viewer

GIS tool for sub-national aggregation

Integrated user interface

Configuration file for controlling tools and models

Manual writing of configuration file

Potential usage of AIM/Impact[Country]

- Outside AIM project.
  - Researchers, governmental officers or others who want to assess future national impact of climate change.
  - Interactive user interface and ready-made datasets are provided for instant achievement of scenario analysis.
  - Spatial visualization is achieved with a plain spatial data viewer controlled from AIM/Impact [Country] interface.
- Inside AIM project.
  - Model is improved by replacing parameters or using more detailed data for specific countries.
  - Use of IDRISI-GIS is recommended.
  - Source code and the latest databases are shared among the teams for flexibility and further refinement.

Development schedule

- First version :End of this year.
  - Presentation of preliminary assessments using AIM/Impact [Country] is expected at the AIM Workshop in March 2003.

- Public distribution: End of next year
  - After the review process by the collaborative researchers.