Impact Model for EGP

Avinash Kishore
IFPRI, New Delhi

What is IMPACT?

- The International Model for Policy Analysis of Agricultural Commodities and Trade

- A global, partial equilibrium, multi-market, agriculture sector model
  - Linked to global climate-sensitive hydrology and water use models
  - that simulates as outputs global and national production, area, yields, trade, demand, and prices for agricultural commodities
  - A structural model: simulates operation of commodity markets and economic agents
  - The core multimarket model and many of the linked modules are written in General Algebraic Modeling System (GAMS)

- Supports analysis of long-term challenges and opportunities for food, agriculture and natural resources
    - Used in policy analyses of climate change adaptation and mitigation
    - studies on impact of technology development, irrigation investments, and
    - projections of food supply and demand, trade and food security to 2050

  - although global in scope, it has been used in regional and country level analyses and
    - can also be linked to sub-national models

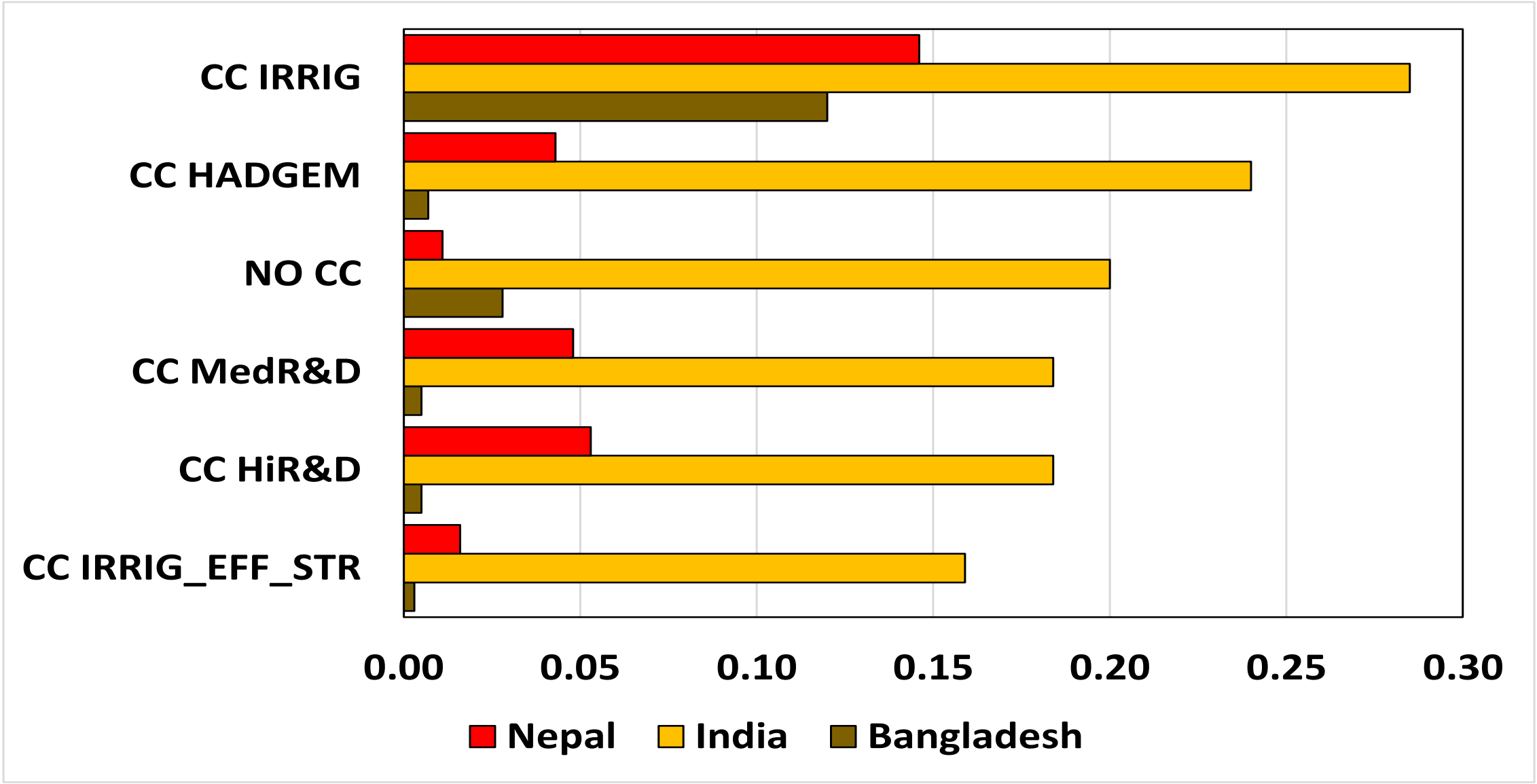
- Designed for scenario analysis, not forecasting

An example: Application of IMPACT in EGP

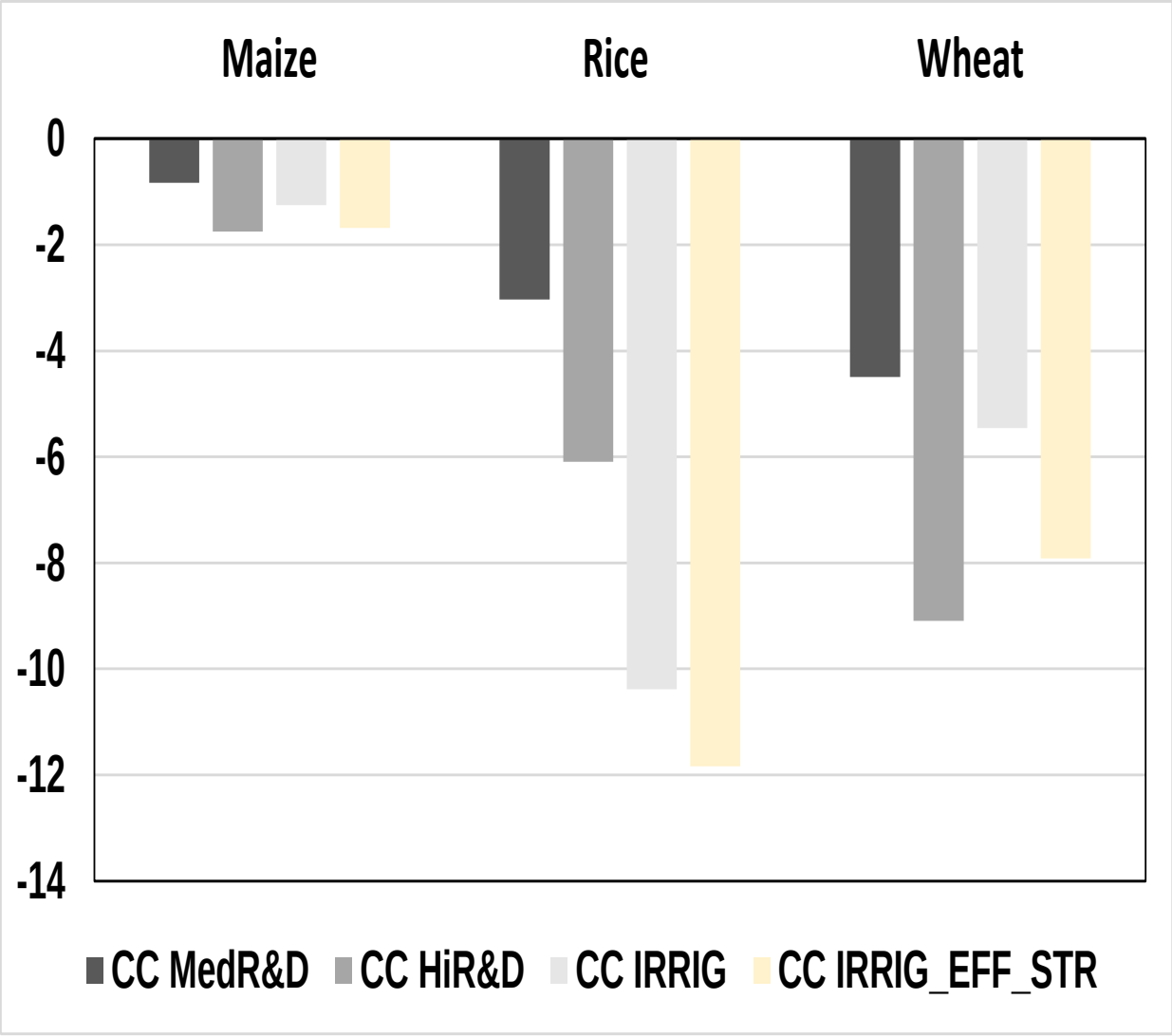
- Baseline assessment of the impacts of climate change on water & food outcomes
- Impacts of three alternative interventions
  - Increased investments in agricultural R&D
  - Increased investments in irrigated area expansion and
  - Increased investments in irrigated area expansion combined with increased efficiency and storage
- Under 2 climate change scenarios

Scenario/Parameters	Yield growth	Irrig Area	Irrig Eff	Storage
No climate change				
Climate change (HADGEM/IPSL)				
Climate change and High investment in agricultural R&D	+0.18%/yr (rice)			
Climate change and Medium investment in agricultural R&D	+0.09%/yr (rice)			
Climate change and investments in expansion of irrigation		40%		
Climate change and investments in expansion of irrigation, irrigation efficiency and water storage		40%	20%	20%

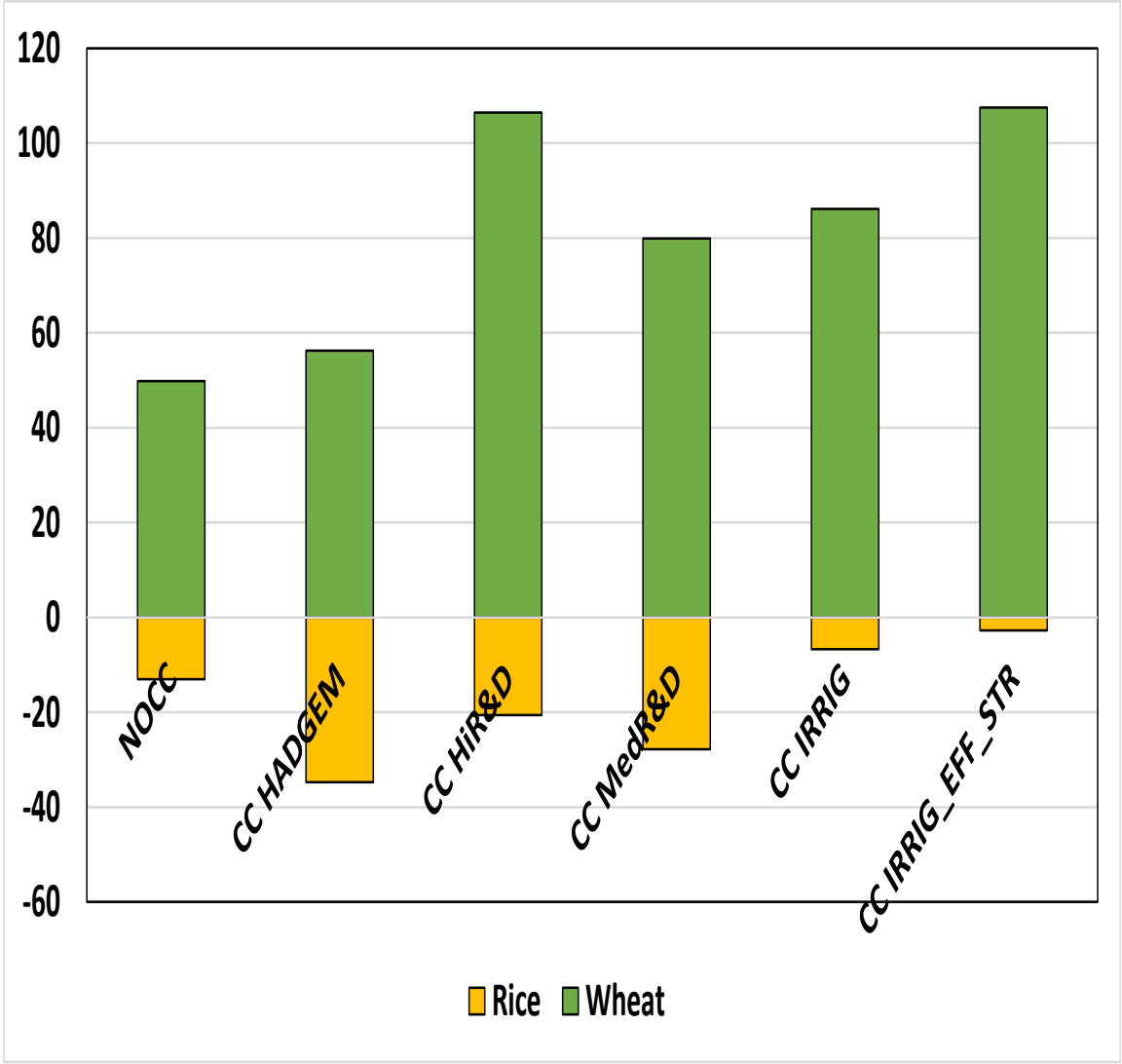
Share of unmet water demands, Bangladesh, India and Nepal, under alternative scenarios



Changes in selected cereal prices 2050 (%) compared to 2050 HADGEM baseline values

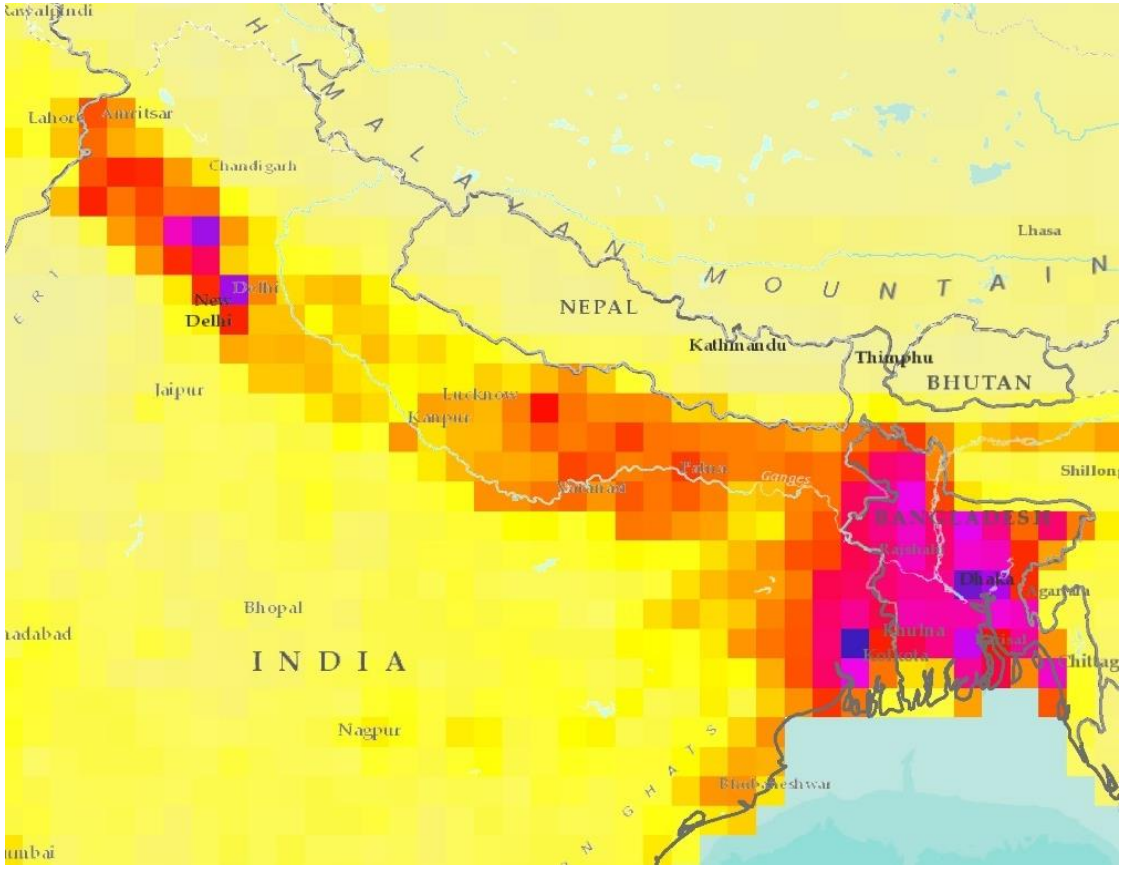


Changes in net trade position for rice and wheat (Bangladesh, India, Nepal) (mmt)



Nitrogen pollution loadings, estimated base period (2000-2009) and projected 2050

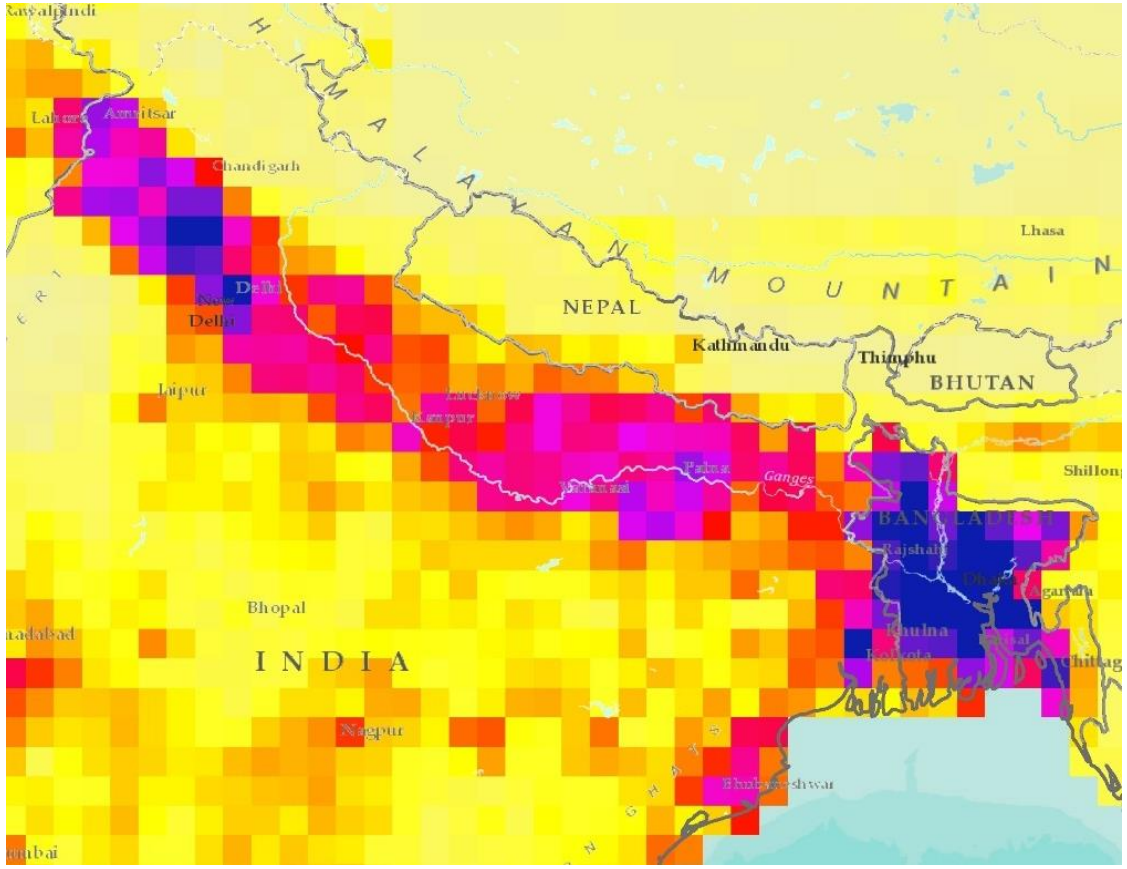
(a) 2000



ton/km2-yr

High : 30 Low : 0

(b) 2050



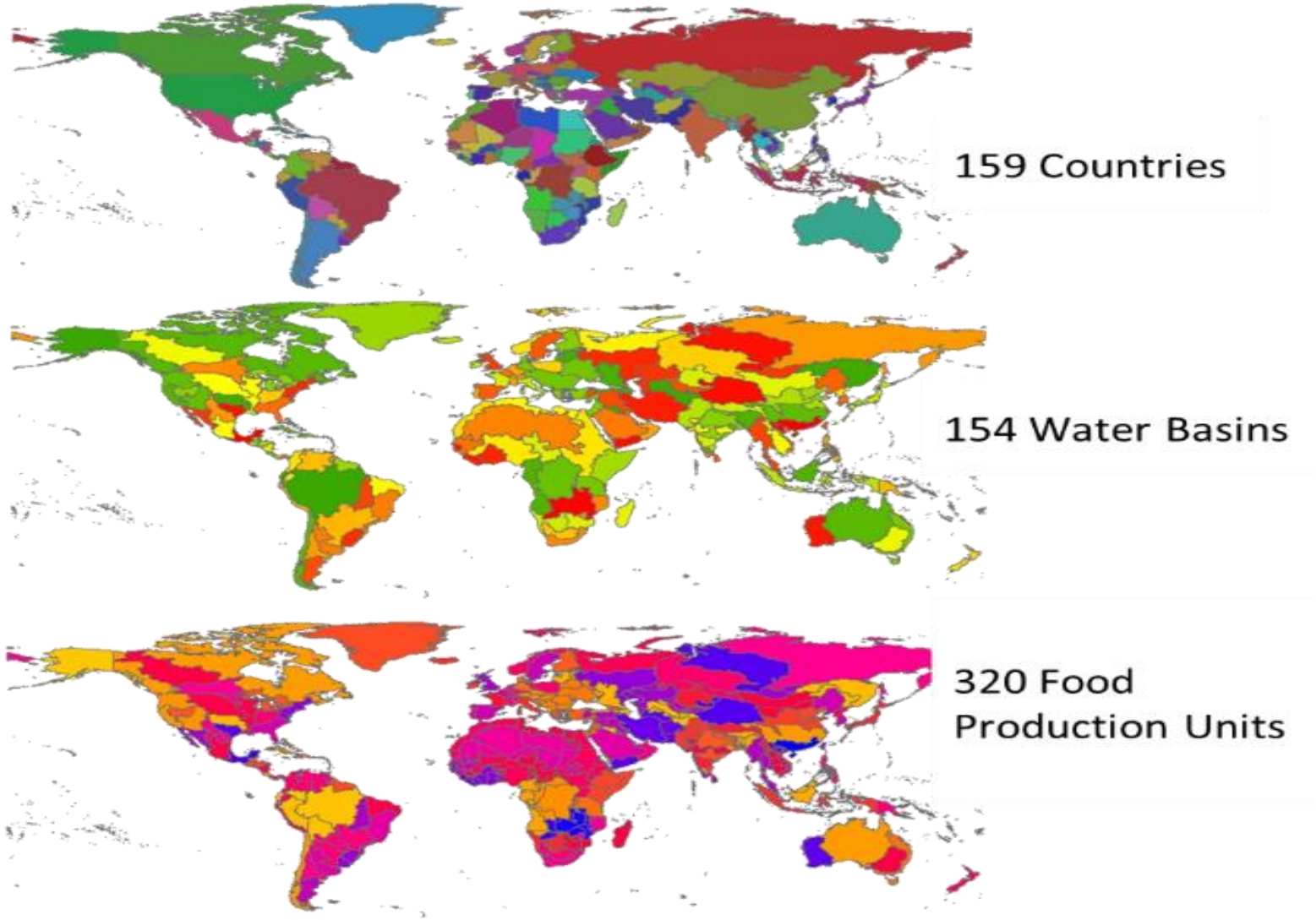
ton/km2-yr

High : 30 Low : 0

- The objective is not to predict the most likely outcome based on the past
- Focus on system dynamics to generate future pathways
  - trends and nonlinear interactions that may deviate significantly from past experience

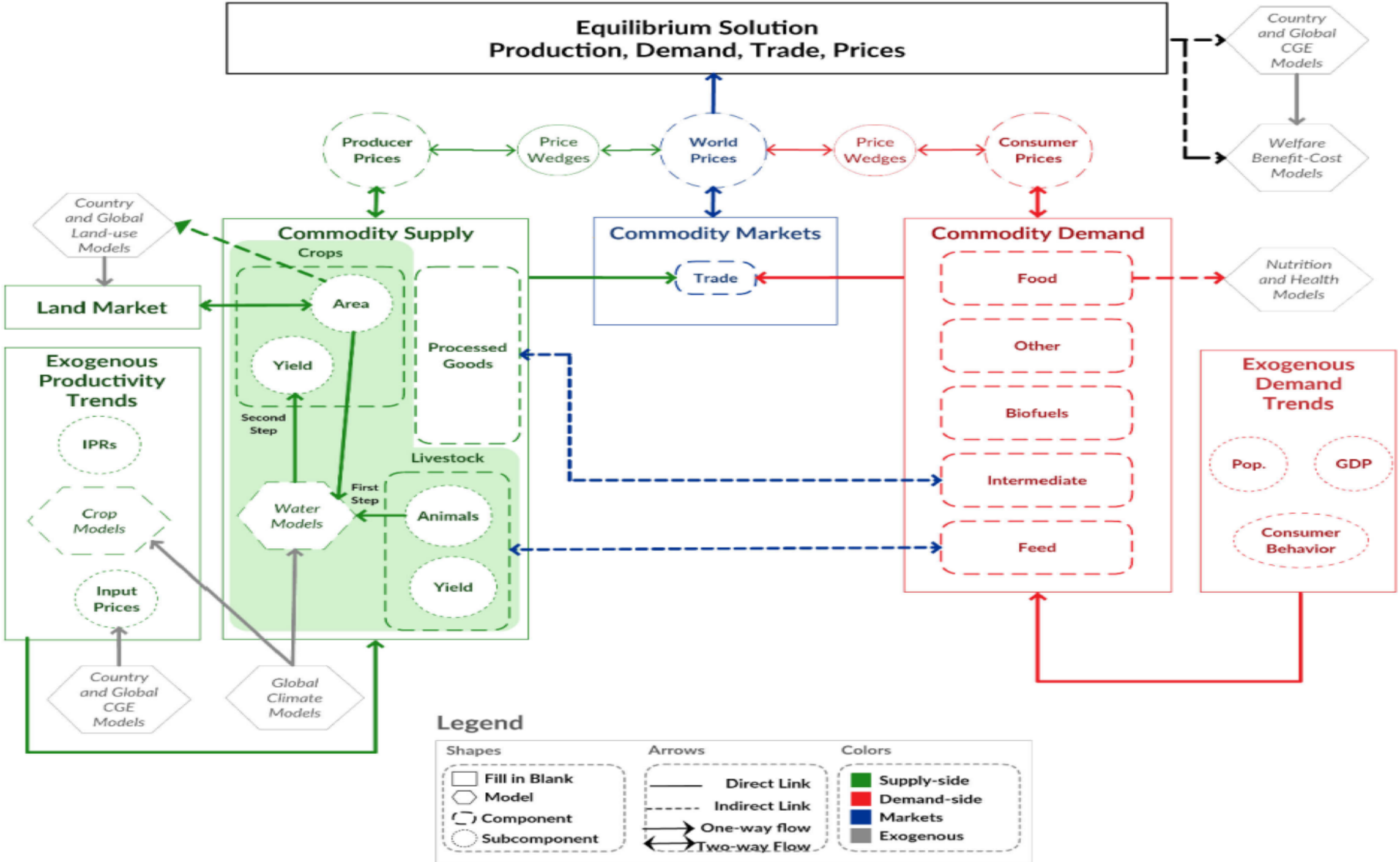
Domain	Examples in IMPACT
Socioeconomic	• Population growth • Education levels • Urban-rural migrations • Gross domestic product and economic development • Income distribution across households • Consumer behavior • Price transmission and exchange rates • Input (fertilizers, pesticides, energy, and so forth) costs
Environmental	• Availability and use of key resources like water and land • Climate change
Political	• Public investment in agriculture research and development • Trade policy (taxes, tariffs, and consumer and producer support policies)
Technological	• Changes in agricultural productivity due to improved genetics, and management practices

IMPACT Model Spatial Resolution



62 Commodities

39 crops, 6 livestock & 17 processed products


Equilibrium Solution
Production, Demand, Trade, Prices
Country and Global CGE Models
Welfare Benefit-Cost Models
Producer Prices
Price Wedges
World Prices
Price Wedges
Consumer Prices
Country and Global Land-use Models
Land Market
Commodity Supply
Crops
Area
Yield
Second Step
Processed Goods
Livestock
First Step
Water Models
Animals
Yield
Commodity Markets
Trade
Commodity Demand
Food
Other
Biofuels
Intermediate
Feed
Nutrition and Health Models
Exogenous Productivity Trends
IPRs
Crop Models
Input Prices
Exogenous Demand Trends
Pop.
GDP
Consumer Behavior
Country and Global CGE Models
Global Climate Models
Legend
Shapes
Fill in Blank
Model
Component
Subcomponent
Arrows
Direct Link
Indirect Link
One-way flow
Two-way Flow
Colors
Supply-side
Demand-side
Markets
Exogenous

Temporal and spatial resolution

- Hydrological and crop simulations are at the grid or cell level, but aggregated to the level of FPU
- Water demand is determined through crop/livestock life cycles, cropping patterns, and competition with non-agricultural sectors at FPU levels
- Agricultural land use and land use change are modeled at the FPU level based on historical trends and expert opinion in responses to agricultural prices
- Commodity markets are cleared annually out to 2050
- The agronomic and water models operate at a monthly time step incorporating standardized crop calendars
- Food demands are simulated for FPUs based on changes in income, population, and prices
- Changes in crop areas and yields due to exogenous (projected public and private sector investment, climate change, etc.) and endogenous sources (e.g. farmer responses to changing prices)

- Commodity supply
  - full implementation of an activity-commodity framework like in CGE models
    - Uses input-output matrices to simulate ag value chains
    - Can incorporate role of exogenous inputs like fertilizers, labor

- Crop production
  - Simulated through area and yield response functions
    - separate for irrigated & rainfed areas
  - Yield is a function of input & output prices, water availability, climate, exogenous trends and new technologies or practices

- Markets, trade & equilibrium prices
  - System of equations in GAMS 2012 to find a set of domestic and world prices for all crops to clear both domestic and world markets
    - World price is the equilibrating mechanism for traded commodities [world production = world demand each year]
    - Price transmission equations for world to producer/consumer prices
    - Prices are endogenous in the system of equations for food.

Water

- The water model consists of three separate modules:
  - A global hydrology model (IGHM) [climate-forcing data: effective rainfall, PET, actual ET and runoff]
    - Solution of IGHM is depends only on climate inputs; independent of other modules
  - Water basin management models (IWSM) [optimally manages water basin storage and irrigated water supply]
  - Water stress models (ICWASM) that determine the impact of changes in water supply on crop yields
- The demand for water in IWSM depends on allocation of land to crops which is part of the solution of the multi-market model. Changes in water availability from IWSM affect water allocation and stress in ICWASM
- There is a 2-way link between the IWSM and the multi-market model

The validation challenge

- Structural simulation model
  - Many parameters and functional forms are not estimated econometrically
- Scenario analysis
  - Outside the range of historical data
- Long-term scenarios
  - Back-casting is difficult

- Validation through
  - Validity of structural design of the model
  - Testing reasonableness of parameter estimates using various data sources
  - Testing models with historical projections wherever possible


Thank you
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