Bhutan's leapfrogging challenge in energy access aiming at carbon-neutral society

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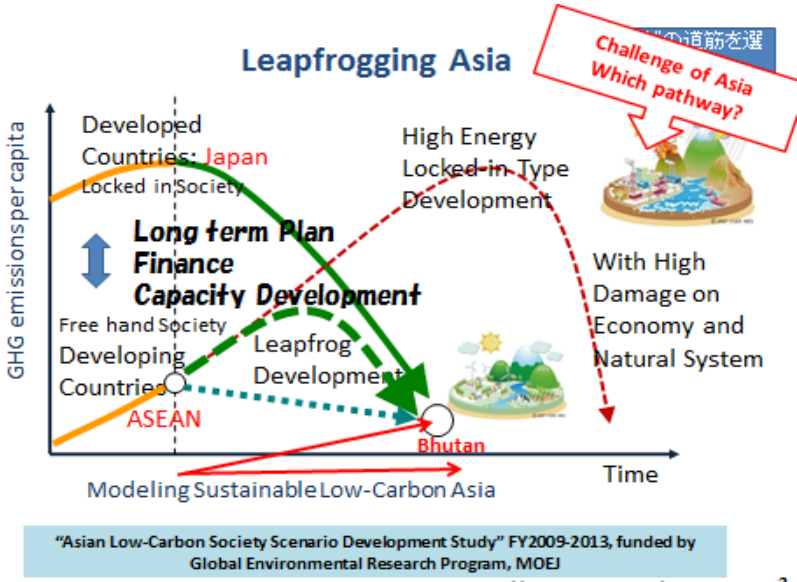
- Lately coming developing countries can not (needs not to) track same hi-carbon development pathway to carbon neutral world
- How natural resources dependent development countries challenge to carbon neutral world and confront to energy access issue?
- Can they create alternative development pathway, technologically, economically and socially, by leapfrogging beyond high-energy intensive modern society, taking this transition as leverage?
- What impacts climate change and responding strategies give to countries' sustainable development pathway?
- Can case of Bhutan be transferable to other developing countries?

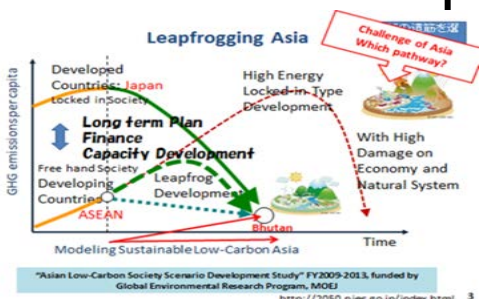


"Asian Low-Carbon Society Scenario Development Study" FY2009-2013, funded by Global Environmental Research Program, MOEJ

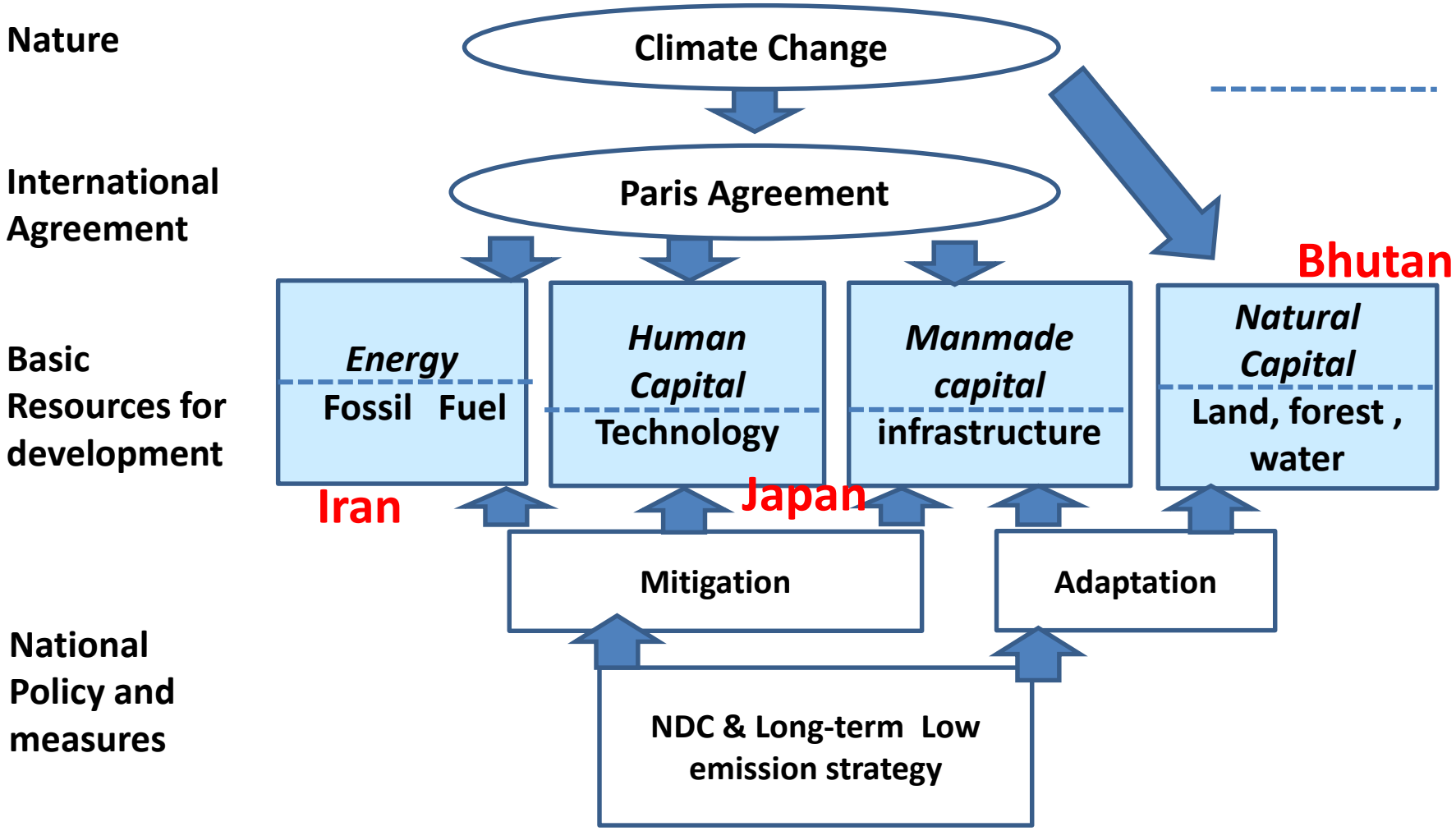
http://2050.nies.go.jp/index.html

Can Bhutan leapfrog? Some leading runners, leverage, tailwind

Issue	*Country*	*Internal factors*	*External factors*
Industrial structure	India: '90s IT industry, Bangalore	Education/ human resources	Soft technology start Globalization
Energy structure	Japan: '70s Low energy intensity	Technology Rapid growth /pollution	Oil crisis Energy security
Bioenergy	Brazil: '70s Bioethanol	Sugar cane Scarce oil	Oil crisis Energy security
Information technology	China: '00s- Mobile phone	Rapid economic growth, poor telephone-grid	IT technology globalization
Renewable energy / EV	China: '00s Wind/solar energy/EV	Big land area Technology/ pollution	Decarbonizing trend Climate change
Develop-ment path?	Bhutan ～2050s High dependence to external fund High transportation cost Inadequate infrastructure	Political stability Natural and Pristine environment Competitively pricing energy Nation of GNH Wide use of English language * 8	Carbon neutral world International cooperation climate finance capacity building



Climate Change is Changing Values of National Development Resources



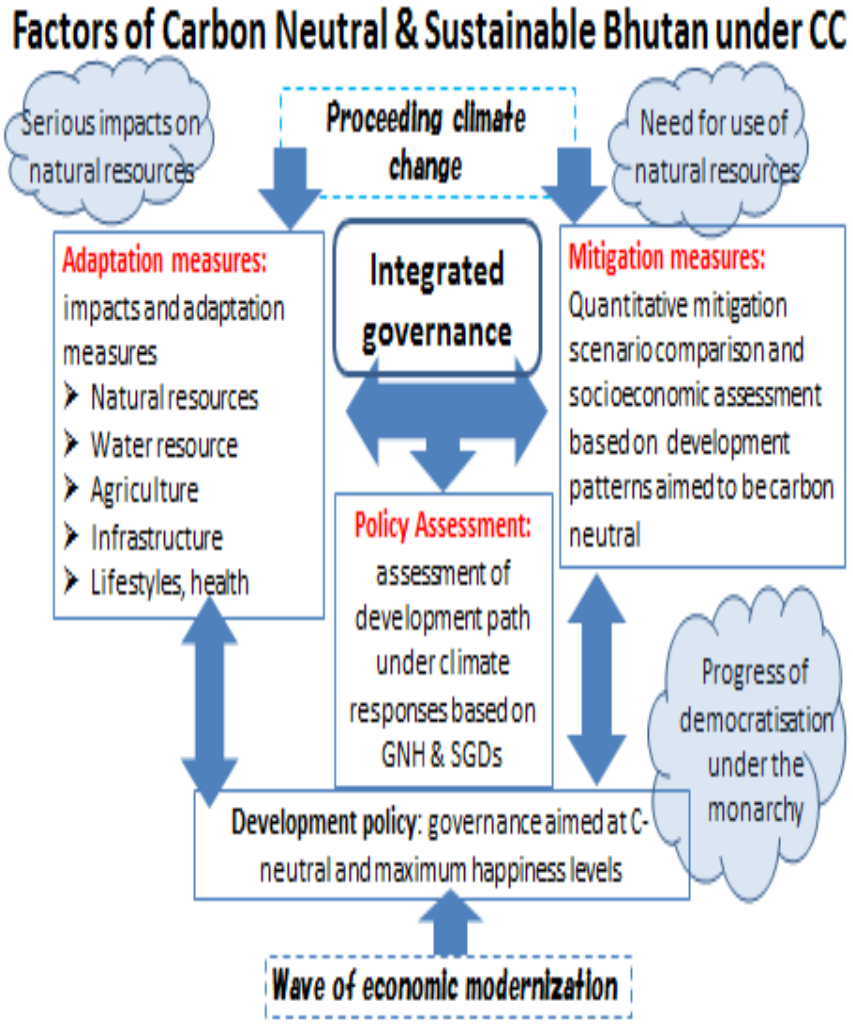
Bhutan: What affects carbon neutral path and energy access?

External factor : climate change

- Change of precipitation and hydrology: impact to capacity and stability of hydropower, Disaster: land slide, soil erosion, burst of glacier lake
- Degradation of : forest /soil/agricultural land ⇒carbon sequestration & biomass capacity
- Paris agreement
- Wave of globalization

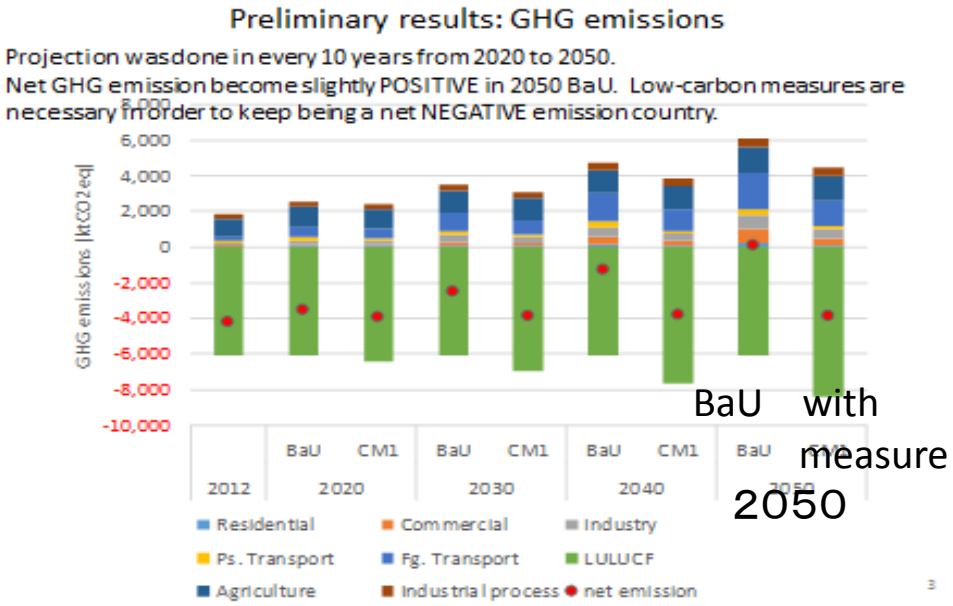
Internal factor: development path under democratization and globalization

- Democratization: high educational level/ informational environment
- Industrialization/ Globalisation:
- Urbanization/ depopulation in rural area
- Governance under GNH concept



Nature dependent Bhutan*3*4

- Population: 0.8 Million (2015: WB)　Area: 40, 000km^2 (half of Island of Ireland)
- GDP/cap. US$ 2532 (PPP US$ 7,653）Foreign assistance shares 1/3 of national revenue
- Food security: Rice, livestock & vegetables are self sufficient（under subsidy)
- Energy almost based on Biomass (60%of total energy consumption) and Hydropower, (13%) : imported oil for cars and industry (Cement, Ferro-alloy)
- Hydropower: domestic demand + export to India (account up nearly 1/4 of national revenue) . More than 10 times potential of present capacity
- Already carbon minus (absorbing) & declare to be Carbon Neutral country (INDC: 2015） tCO$_2$/Cap: 2.9 (2005)⇒ BaU 4.9 (2040)



Gomi &Ochi 2016

Biomass, pollution, electricity & absorption

- **Total energy** demand in 2005（& 2040 baseline projected* ）387(730) 10^3toe, per capita 0.5(0.75) toe/Cap.(almost same as India)
- **Supply:** fuel wood 60% (22%), hydro-power13%(44%) , imported gasoline/ diesel/ kerosene 20%(25%), coal 7% (6%) ⇒self sufficiency 3/4 (2/3). Accessibility to electricity is 97%.
- **Consumption:** residential: rural 32%(14%), urban 4%(15%), energy intensive industry 9%(17%), other industry 12%(25%), tertiary industry 10%(17%), agriculture/forestry 14%(1%), Transportation 14%(12%)
- **In 2040**, total energy increases 2.4 times, fuel wood stable, hydro-power increases 8 times, fossil fuel increases 2.6 times ⇒self -sufficiency decreases

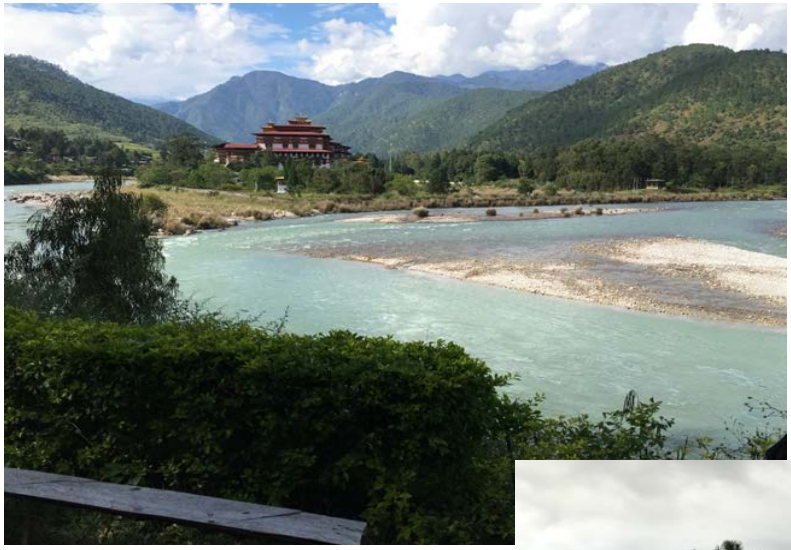
- **Absorption:** Forestry, coverage of 70% of land area (National target: 60%) keeps absorption.
- Biomass : fuel wood for cooking and warming causes indoor/urban air pollution.
- **Bio-diversity:** Half of land area designated as national park, preserving bio- diversity, and contributing to eco-tourism.

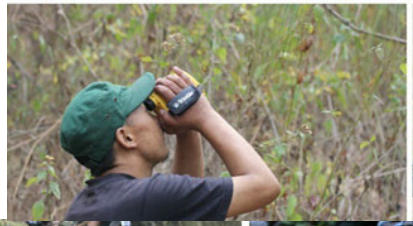


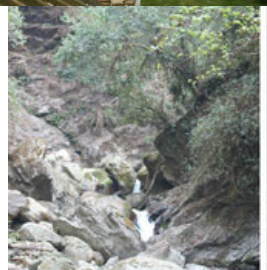


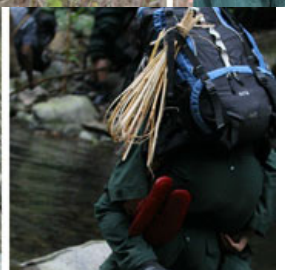


Natural resource & its management









Governance

- Development Plan of Bhutan bases on "Gross national Happiness (GNH)" concept
- GNH Indices for 9 domains:
  - Psychological well-being, Health, Time use (Work, Sleep), Education, Cultural diversity and resilience, Good governance, Community Vitality, Ecological diversity and resilience, Living standard (Income, Asset, housing)
- Nine areas with same weight are defined ⇒

Indices for the 9 domains

Width of a box shows weight given to each index

Psychological wellbeing	Life satisfaction	Positive emotion	Negative emotion	Spirituality
Health	Self-reported health status	Number of healthy days	Disability	Mental health
Time use	Work	Sleep		
Education	Literacy	Schooling	Knowledge	Value
Cultural diversity and resilience	*Zorig chusm* skills	Cultural participation	Speak native language	*Driglam Namzha*
Good Governance	Political participation	Services	Governance performance	Fundamental rights
Community vitality	Donation (time & money)	Safety	Community relationship	Family
Ecological diversity and resilience	Wildlife damage	Urban issues	Responsibility to environment	Ecological issues
Living standards	Income	Assets	Housing	

- Nation-wide surveys (9,000 sample) in 5 years cycle monitors peoples satisfaction in detail index.

At 2015 survey *[7]:

- Deeply or extensively happy 43.4%, narrowly happy 47.9%, unhappy 8.8%.
- men> women, urban resident> rural , more educated> less educated tend to be happier
- Increased satisfaction on services: electricity, tap and sewage water and housing
- psychological well-being and government performance degraded 2-25% from 2010

Relationship between GHH and develoment

Relationship between GNH and Development path

GNH Index	No. of Pop. /Household	Economy	Transport ation	Energy	Agri-culture	Land-use	Waste	GHG
Psychological Wellbeing	Family structure			Electrification rate				
Health	Age distribution		Walking trip					
Time use		Labor Hour						
Education		Promoting Education						
Cultural diversity & resilience					Domestic productio n rate			
Community vitality	Family structure	Income						
Good governance			Public transporta tion	Electrification rate		Forest Area	Waste manage ment	
Ecological diversity & resilience						Forest Area	Waste manage ment	GHG emission
Living standard	Family Structure	Income	Modal share					

Gomi & Ochi 2016

Impacts by globalizing economy, urbanization and democratization

Current Trend

Economy

・GDP/cap (2011) US$ 2,590

・Growth rate (2006年～2011) 7－8%/y

・Unemployment rate 3%,

・National income： domestic 65%, assistance 35%

・Working Population: Agriculture (subsidized) 69%, 2nd & 3rd industry are still small

Domestic migration

・Increasing population and migration to urban area, especially to Thimphu

・With increasing investment on infrastructure and industry, air/water /waste pollution increasing in urban area. Stable safe drinking water provision is at risk.

・Country side suffers from human- animal conflict

Literacy

・Literacy in young generation is 95%, elder than 65 is 20%. School education performed by English.

・Electricity is provided 97% of household, TV75%, mobile 98%, which deliver world newest information to home

Governance: Development Plan

Democratization

Maximize GNH:

・Sustainable and equitable social and economic development

・Preservation of natural environment

・ Maintenance/promotion of culture/ tradition

・Good governance

Development Plan:

・High value, low volume
High–tech, Medical industry, Education business,

・Self resilience & full employment.
Enhance variety of export industry under “Brand Bhutan“:

・Carbon Neutral policy

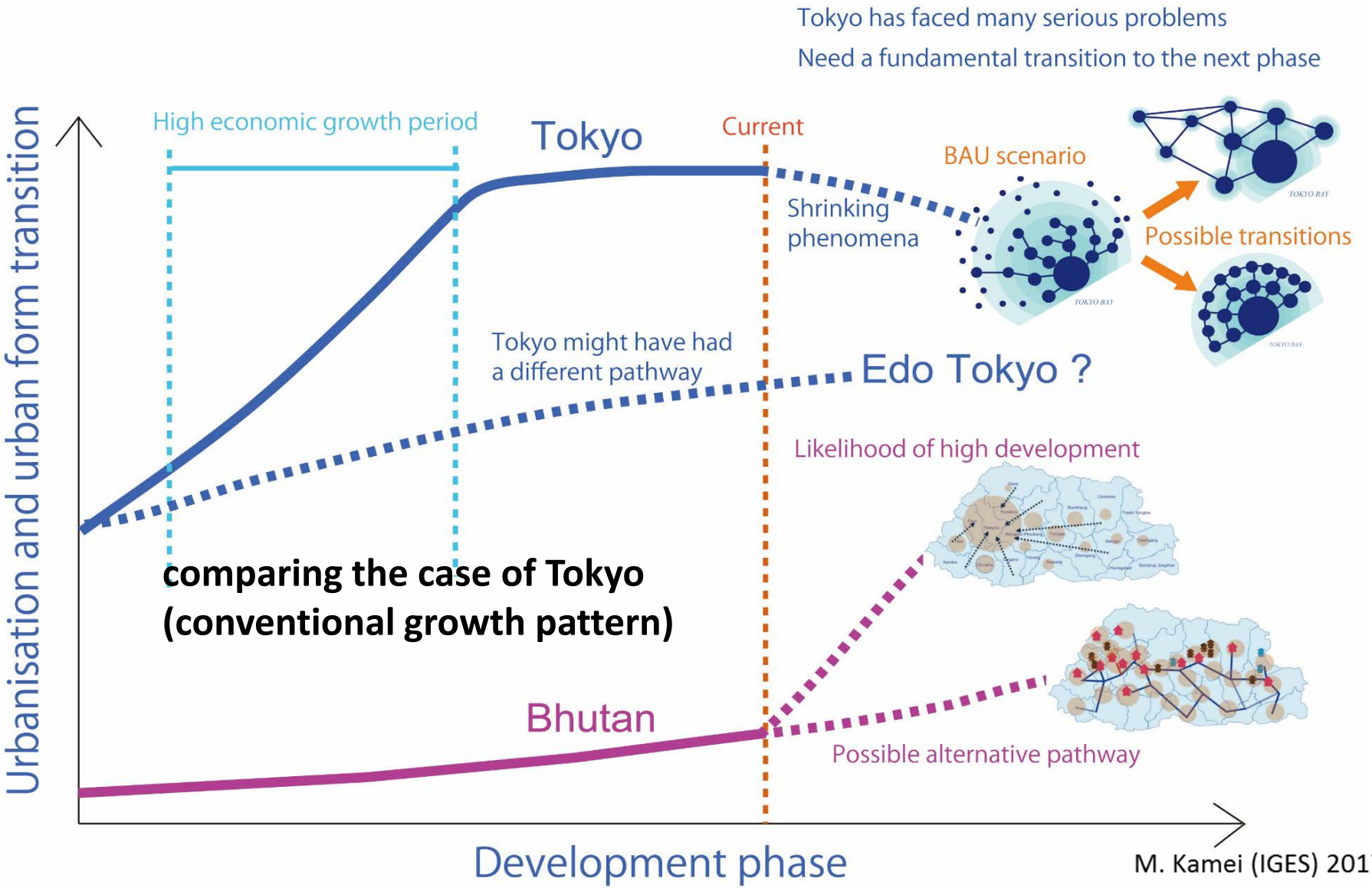
NDC for CC

Land use plan:

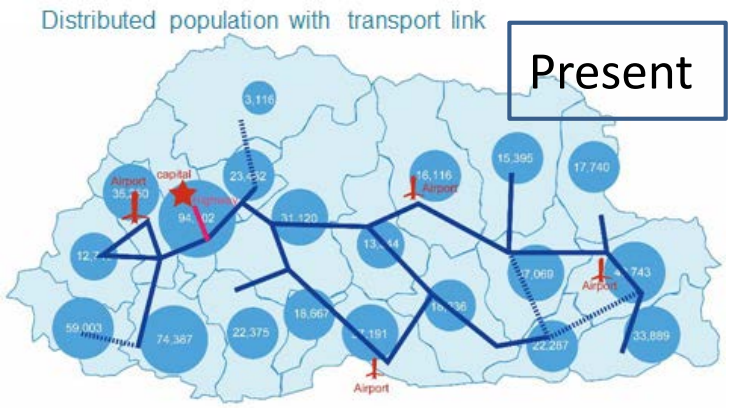
・Decentralization policy, Dry port

Can Bhutan develop with full satisfaction of peoples by preserving it vernacular culture and affluent natural resources? A big challenge.

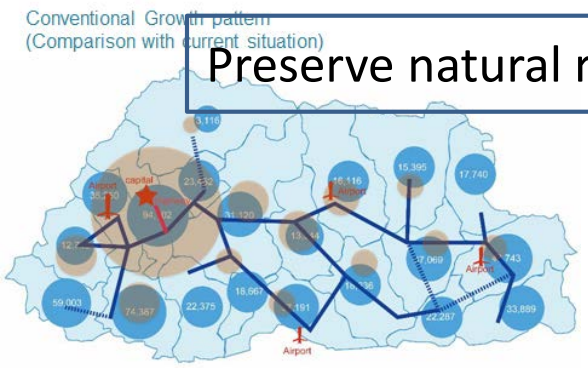
How to keep local population to preserve natural resources, tradition, heritage and culture : Dynamic & integrated national land-use plan is indispensable



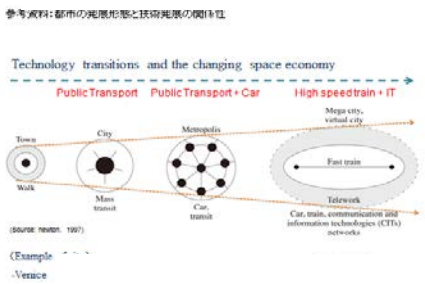
Land use plan under carbon neutral & Gross National Happiness



Present

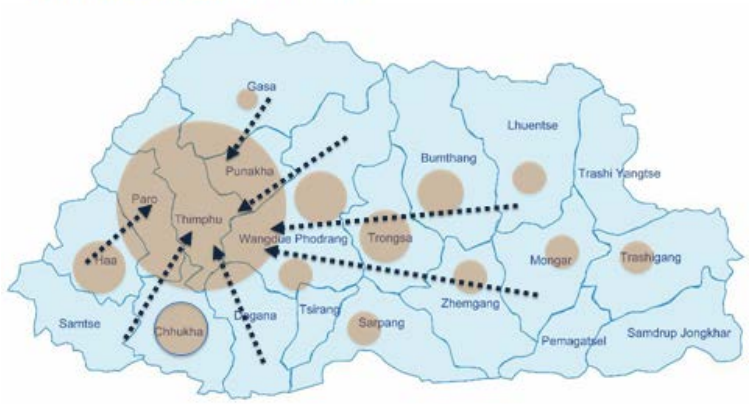


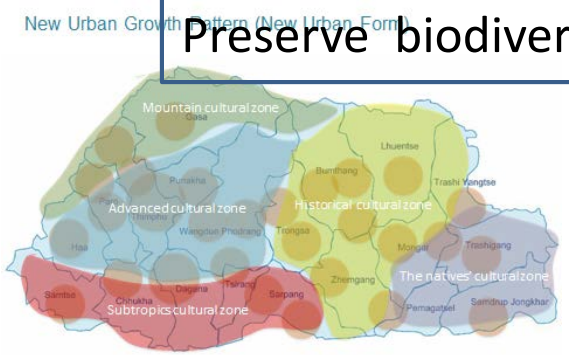
Preserve natural resources



BaU

Preserve culture , tradition and heritage





Preserve biodiversity

M. Kamei (IGES) 2017

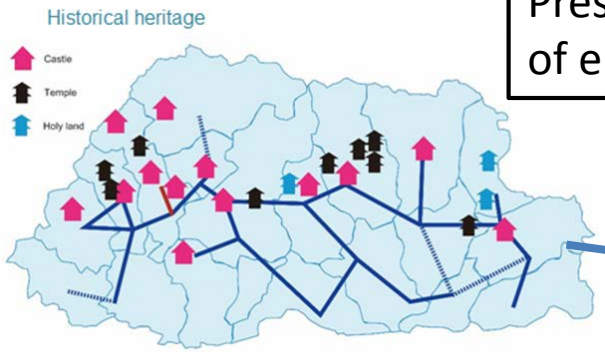
How can natural resources be preserved?
Importance of national level land- use planning

Maximize Gross National Happiness

Maintain vernacular culture and tradition

Preservation of environment

Good Governance
National Development plan



Changing climate

How to develop with less carbon?

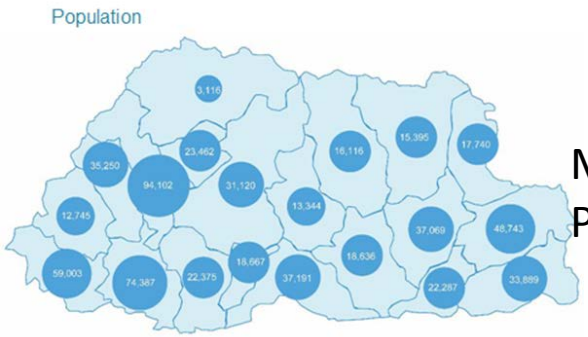
National Low carbon development path way

Industry
Business
Population
Agriculture
Absorption, hydro-power
Biomass,
Biodiversity

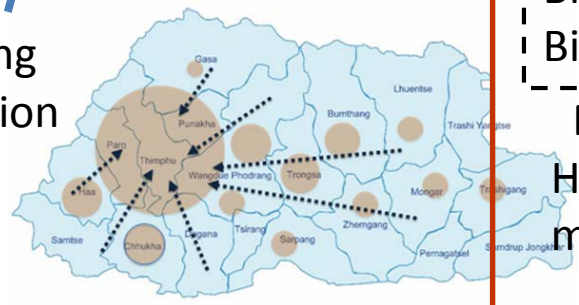
Top-down

Dynamic Dialogue

Bottom-up



Migrating Population



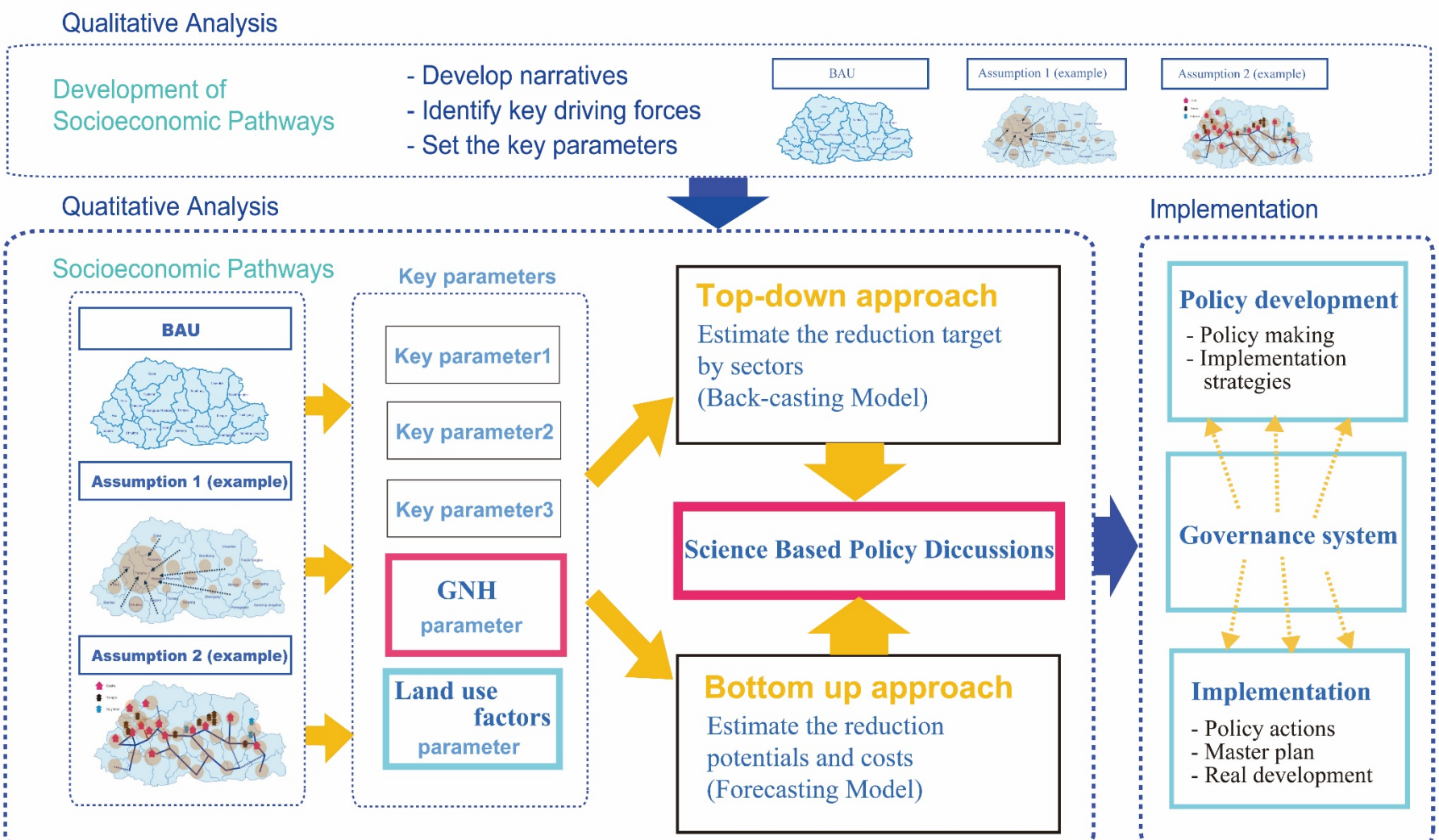
National Land-use plan

How to settle population for maintain natural resources?

M. Kamei (IGES) 2017

Dynamic Land-use Planning Method towards Carbon Neutral Bhutan

- Re-evaluation of local natural resources
  - energy, absorption, agriculture, biodiversity, culture
- Consideration to long term migration dynamics
- Dynamic population settling policy with local core industry)



Findings & Discussion

Case study on Bhutan to leapfrog suggests necessity of :

- strengthening scientific bases of carbon neutral society focusing in natural resources
- Impact assessment of climate change to natural resources: hydrology, forest and land/ soil degradation, and adaptability
- Natural resources preservation policy: How to settle stable rural population in the process of development
- Strong governance under GNH concept

Discussion

- Will GNH be the new guiding principle to reach to carbon neutral society?
- Can Bhutan show possibility of new nature harmonized development path by utilizing leapfrogging chance of big transition?
- How the Bhutan's carbon neutral policy be transferred to other developing country? What are the barriers?


Punaka, Bhutan


Azumino, Japan

Thank you very much for your attention!

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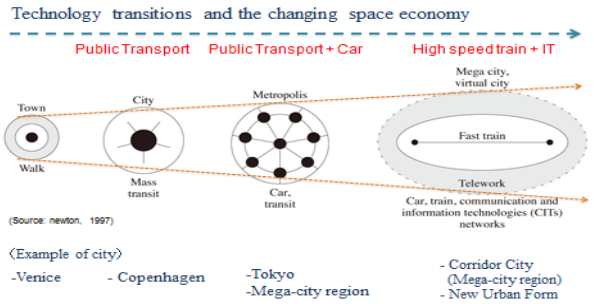
Innovative Dynamic Land-use Planning Method towards Carbon Neutral Bhutan

- Re-evaluation of local natural resources
  - energy, absorption, agriculture, biodiversity, culture
- Consideration to long term migration dynamics
- Dynamic population settling policy (core industry and self-sufficiency)

参考資料：都市の発展形態と技術発展の関係性

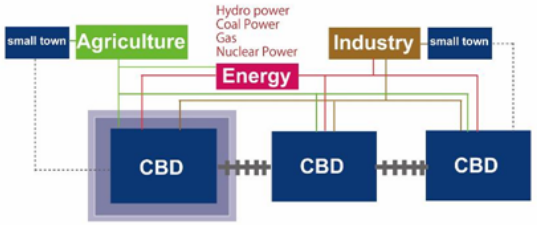


〈Example of city〉

-Venice - Copenhagen -Tokyo -Mega-city region - Corridor City (Mega-city region) - New Urban Form

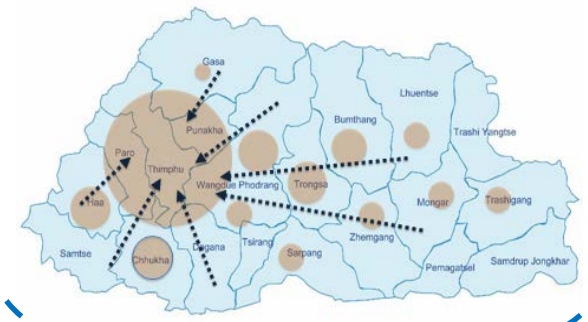
参考資料：Conventional Growth Pattern (著者作成：IIASA YSSP,2014より)

Driving force: Economy – typical growth pattern in1960'-1980'
Mainly Central Business District (CBD), financial centre, business headquarter



Conventional Urban Growth

Conventional Growth Pattern

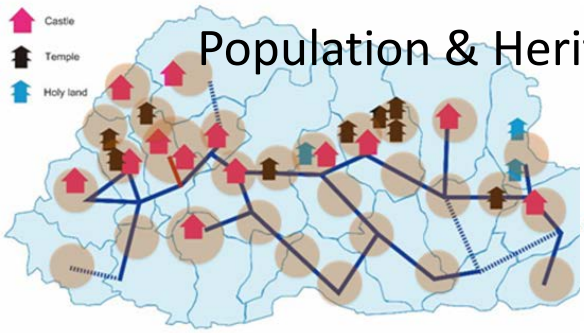


参考資料：New Urban Growth Pattern (著者作成：IIASA YSSP,2014より)

Driving force: Activities - New urban form (Hall, 1999)
Diverse of activities (Central Business District (CBD), factories, agriculture)

New Urban Form

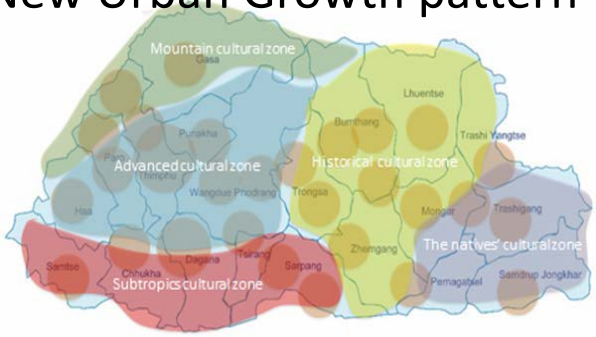
New Urban Growth Pattern (New Urban Form)



Population & Heritages

New Urban Growth Pattern (New Urban Form)

New Urban Growth pattern



Transport link

Transport link

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Food & Agriculture