

Research to support development policy in natural resource-dependent developing countries in their responses to the global transition to carbon neutrality

Configuration of Integrated Research Project*

The above figure gives a bird's-eye view of the integrated research project on carbon neutral development for natural resource-dependent developing countries. The project comprises three sub-topics, 1) assessment of climate change impacts on natural resources, such as absorption required for carbon neutrality and renewable energies like biomass and hydropower energy, and their adaptation measures; 2) projection of carbon neutral development scenarios that factor in climate change impacts on these natural resources, examination of land use; and 3) assessment of anticipated policy sets from the perspective of GNH. Likewise, it includes dissemination and sharing of knowledge gained from this research project utilising networks.

Features of the Integrated Research Project

- 1 Research from the perspective of impact assessment and adaptation measures will take place on precipitation and hydrology in Asian mountainous countries that fall in a global gap and experience the unique phenomenon of high mountain weather.
- 2 Research from the perspective of carbon neutrality policy will take place on long-term strategies that integrate impact assessment, adaptation and mitigation in already carbon neutral natural resource-dependent nations. Knowledge transfer to countries in similar situations that are rich in forests and hydropower resources, such as Laos, Myanmar, Nepal and Indonesia, is to be expected.
- 3 Viewed in relation to developing country development policy, the target of this research, Bhutan, is aiming for governance and carbon neutral development based on GNH. As societies around the world move toward development under the SDGs, nationwide carbon neutral development incorporating GNH, a pioneering concept in multi-dimensional development goals, will provide significant suggestions to future discussion on development in developing countries.
- 4 This multidisciplinary, integrated synthetic research project, in cooperation with policymakers, researchers and other stakeholders, will advance policy recommendations in developing countries needed to make the transition to carbon neutral societies based on scientific knowledge.

*Of these, depiction of carbon neutral development scenarios that factor in impacts on natural resources and dissemination and sharing of knowledge gained from this research project utilising networks are implemented with funding from the Research and Information Office of the Global Environment Bureau of the Ministry of the Environment.

Timeline of feasibility study on full-fledged cooperation

- 2015 Initiation of feasibility study based on funding from the Research and Information Office of the Global Environment Bureau of the Ministry of the Environment
- Dec 2015 IGES/NIES 1st Bhutan visit (NEC, Ministry of Agriculture and Forests, JICA Bhutan office): Presentation of overall plan at a joint meeting of ministries and agencies on climate change
- Oct 2016 Organisation of the Japanese joint research team
Coordinator: IGES
Climate change impact assessment: Tokyo-Tech/NIES
Examination of long-term carbon neutrality scenarios: NIES/IGES/E-konzal
Carbon neutral land use planning: IGES/NIES
Carbon neutrality policy assessment based on "Gross National Happiness": IGES/NIES
- Oct 2016 IGES/NIES 2nd Bhutan visit (NEC, RUB/CNR, UWICER, CBS, JICA Bhutan office): Presentation of carbon neutrality scenario V1 towards NDC support
- July 2017 Tokyo-Tech/IGES/E-konzal 3rd Bhutan visit (NEC, UWICER, RUB/CNR, NCHM, CBS, JICA Bhutan office): Agreement on joint research with NEC, UWICER and RUB/CNR
- Sept 2017 Presentation of the research programme on Bhutan's carbon neutral development at the 9th Annual Meeting of the International Research Network for Low Carbon Societies (United Kingdom)
- Oct 2017 Training by NIES for 2 persons from Bhutan's NEC/Ministry of Finance on economic evaluation of carbon neutrality policy (Tsukuba, 7 weeks)
- Oct 2017 NEC and IGES sign MoU on comprehensive research cooperation
- Nov 2017 Participation by Bhutan, Indonesia, Laos and Nepal in a session on "Carbon neutral development in Asian natural resource-dependent nations" at the 6th Annual Meeting of the Low Carbon Asia Research Network
- Jan 2018 Tokyo-Tech/IGES/NIES 4th Bhutan visit (NEC, UWICER, NCHM, RUB/CNR, RUB/iGNHaS, GNHC, MoWHS)
- Feb 2018 Training by NIES/IGES on climate change for a team of 12 persons from Bhutan's various ministries and agencies (Tsukuba, 1 week)

Participating institutions and abbreviations in Bhutan-Japan joint research

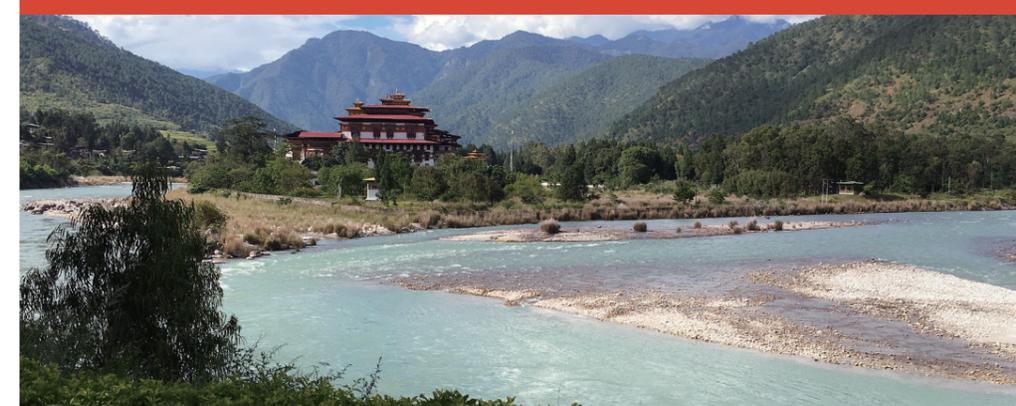
CBS	Centre for Bhutan Studies & GNH
E-konzal	E-Konzal Co. Ltd.
IGES	Institute for Global Environmental Strategies
MoWHS	Ministry of Works and Human Settlement
NCHM	National Center for Hydrology and Meteorology
NEC	National Environment Commission
NIES	National Institute for Environmental Studies
RUB/CNR	Royal University of Bhutan/College of Natural Resources
RUB/iGNHaS	Royal University of Bhutan/Institute for GNH and Sustainability
Tokyo-Tech	Tokyo Institute of Technology
UWICER	Ugyen Wangchuck Institute of Conservation and Environmental Research

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— Insights from case of Bhutan —



In order to achieve the major transition to global carbon neutrality as set forth in the Paris Agreement, both substantial reductions in greenhouse gas (GHG) emissions on the developed nation side, as well as initiatives to maintain absorption capacity in developing countries with natural resources, such as forests and hydropower resources, are indispensable. Natural resource-dependent nations in Asia, including Laos, Myanmar, Indonesia, Nepal and Bhutan, are working to maintain carbon absorption, as each respective nation searches for ways to transition to carbon neutral development based on forests, biomass and hydropower resources.

Although Bhutan is a small nation, it has a great potential to lead the developing world in low-carbon development policy in the future. In its INDC, Bhutan internationally declared its intent to carry out carbon neutral development. As such, the nation is working to develop policy to preserve forests and promote the use of hydroelectric energy based on its Gross National Happiness (GNH) Index. Meanwhile, climate change is expected to wield impacts on its natural resources, including forests, soil, and hydropower and water resources, and serious concerns have arisen that economic development amid globalisation could increase GHG emissions.

This research aims to provide Bhutan (and other Asian nations) with scientific information to support the preparation of NDCs and long-term carbon neutrality strategies. In cooperation with policymakers and research institutions in Bhutan, it will examine long-term scenarios and associated policies to achieve balance between emissions from industrial development and absorption from forests and soil, while giving consideration to projection of climate change impacts and adaptation measures. In so doing, the scientific basis for improvement in Bhutan's NDC within the UNFCCC process will be formed and the scientific capacity to maintain carbon neutrality policy will be created. The outcomes of this research will be shared among other natural resource-dependent nations worldwide via the International Research Network for Low Carbon Societies (LCS-RNet) and the Low Carbon Asia Research Network (LoCARNet).

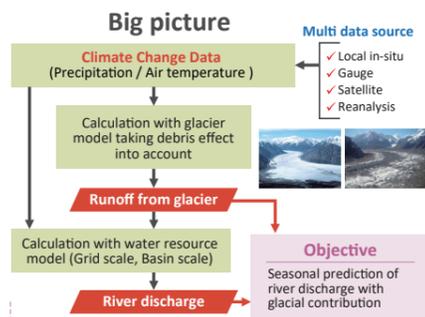
The extent of climate change impacts on natural resources

Adaptability

What are the impacts on precipitation, hydrology and hydroelectric power generation?

Hydropower resources are important economic resources for Bhutan. Not only does hydroelectric power reach almost every household via power grids stretching across the nation, revenue from sales of electric power to India sustain about 1/4 of national finance. Hydropower potential is estimated to be ten times the current amount, making it an essential resource for Bhutan to pursue economic development while maintaining its carbon neutrality policies in the future.

However, climate change may increase the risk of burst of glacial lakes caused by increased melting of upstream glaciers. Further, changes in river water volume due to altered precipitation and hydrological conditions will not only yield impacts on hydroelectric power generation, but also raise major concerns over the risk of flooding damage or insufficient irrigation water for the limited amount of agriculture conducted on the plains along rivers. Climate in high mountain ranges in the Himalaya region is complex and remains a global gap in climate change forecasting, with analysis as yet insufficient.



This research will be carried out in cooperation with NCHM, that carries out observational research on climate and hydrology, UWICER, engaged in research on preservation of natural resources, and the Tokyo Institute of Technology and National Institute for Environmental Studies (NIES) team that carries out analysis of precipitation data and glacier melting by satellite observation and possesses a watershed hydrology analytical model widely utilised in the Asian region.

How will the absorption capacity of forests and soil change?

Maintenance and expansion of carbon dioxide-absorbing forests and soil is a prerequisite for a carbon neutral world. Further, in Bhutan, the use of biomass along with hydropower is important as a renewable energy. According to a systematic study on the carbon storage of forests and soil at 2,400 locations in Bhutan (photos), 72% of national land is covered with forest. When impacted by climate change, these forests might suffer landslides due to heavy rainfall in steep mountainous areas, dying of trees due to droughts, frequent occurrence of forest fires, propagation and invasion of tree-harming pests, and changes in various tree species according to altitude. As many adaptation measures as possible must be taken to protect forests.

Absorption capacity expands with the sound growth of trees, appropriate use of timber and biomass, and increases in forest area. Gaining

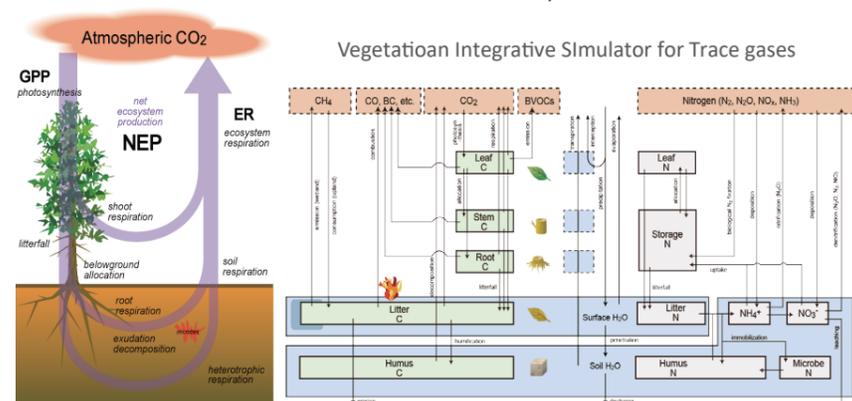
knowledge on the workings of the carbon cycle in Bhutan, a country with a land area approximately the size of Kyushu, would provide valuable scientific information not only for forest policy but also for carbon neutrality policy. Knowledge on preservation and increase of absorption capacity can be gained from on-site data collection by RUB/CNR and the carbon cycle model developed by NIES (figure below).



Forest Resources and Climate Change in Bhutan

Model-based assessment

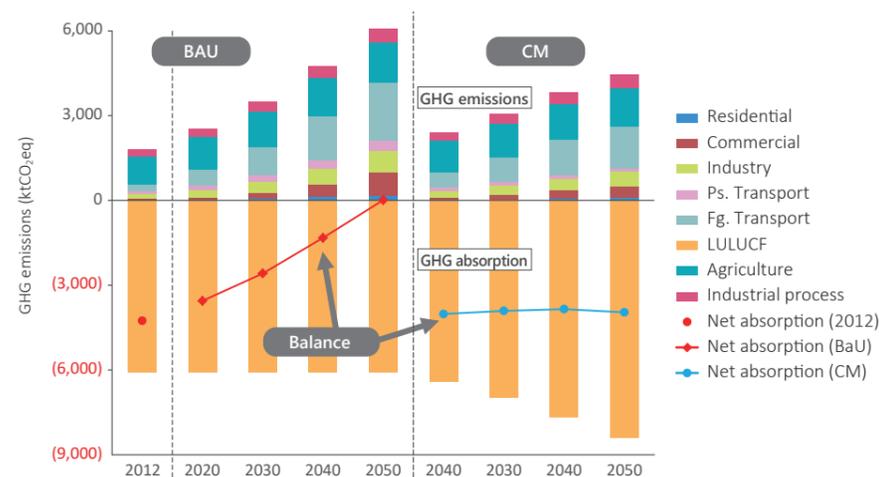
- Representative points along gradients
- Carbon budget, water budget, greenhouse gas exchange etc.
- Validation with inventory and observational data



Can carbon neutrality be maintained?

Examination of long-term emissions and absorption scenarios

Carbon neutrality cannot be maintained without countermeasures to address both emissions and absorption



Carbon neutrality is a state in which emitted carbon dioxide is absorbed in its entirety by forests, soil and oceans, and no excess carbon dioxide is put into the atmosphere. As shown on the bottom left of the above left figure, Bhutan (now in 2012) is a carbon-negative country with low emissions and high absorption. However, if policies are not launched to enhance the absorption capacity of forests and control emissions, the balance between absorption and emissions (red line) will reach zero in 2050, turning Bhutan into a carbon-emitting country from that point on.

Meanwhile, as shown in the bottom right of the figure, if measures to address both emissions control and absorption increase are put in place, Bhutan can remain carbon negative for a considerable length of time (blue line). A wide range of policies is essential to enact such measures, including tangible goal-setting by the government, development strategies with long-term visions, selection of appropriate technologies, and responses to urbanisation.

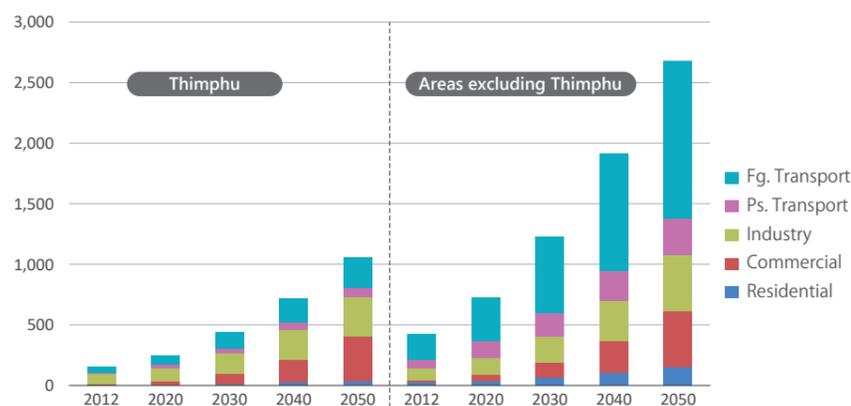
The figure below shows projected GHG emissions up to 2050 supposing BAU development without any special carbon neutrality policies, divided into the urban Thimphu region

and a total for areas excluding Thimphu. As Bhutan's electric power is well distributed, emissions from the residential sector (lowest section on the histogram) are low, but by 2050 would rise 6 to 7 times that of 2012 for all areas. However, there is a difference in the major emission sources. In Thimphu, emissions from the industrial and commercial sectors are high, whereas emissions from transport are larger in other areas excluding Thimphu. Transportation measures, such as introduction of EVs, will be required.

In order to maintain carbon neutrality, efforts such as those shown on both sides of this page are necessary. This research will be carried out based on cooperation between the policymakers of Bhutan's NEC and the Japanese joint research team (NIES, IGES and E-konzal), making use of integrated assessment models (AIM) for carbon neutral development developed by NIES and others.

Note: Both figures (above and below) utilised only existing data for calculations and represents initial and approximate results. Researchers from both Bhutan and Japan will continue to discuss these figures and develop more appropriate projections.

In Thimphu, emissions from the industrial and commercial sectors are high, whereas emissions from transport are larger in other areas excluding Thimphu.



How is the synergy of governance under GNH?

Carbon neutral policy assessment

Major challenge: carbon neutral development based on Gross National Happiness

Gross National Happiness (Indices for the 9 domains) Width of a box shows weight given to each index

Psychological well-being	Life satisfaction	Positive emotion	Negative emotion	Spirituality
Health	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	

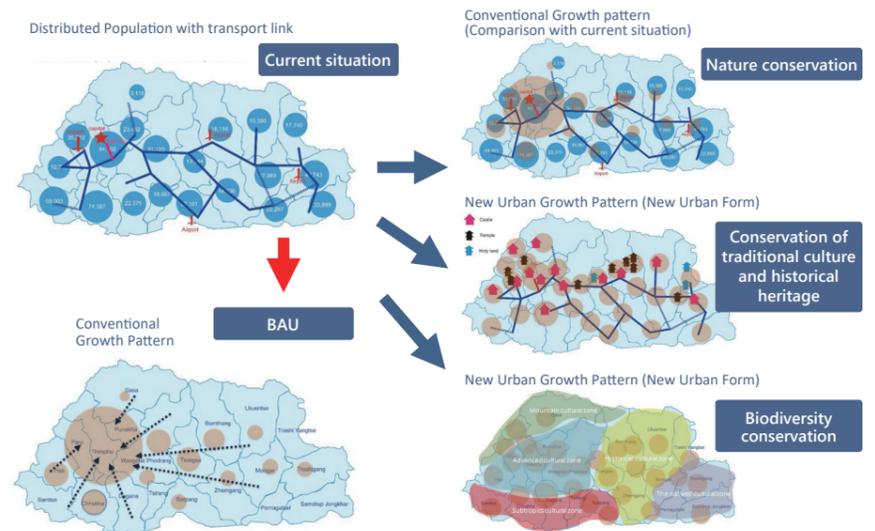
The Gross National Happiness Index was already put forward in Bhutan in the 1970s. At present, it is used extensively as a standard in national governance, including budget allocation and policy assessment. Policy to maintain carbon neutrality is also formulated based on GNH.

As exhibited by climate change, economic activities are about to reach the Earth's limits, and the United Nations has proposed the SDGs as multidimensional development goals not based entirely on economic growth. As seen in the figure above, GNH has many items in common with the SDGs. The GNH index has been employed based on multidimensional development goals and put in place under one unified governance at the national level, and

thus can be considered a forerunner of the SDGs actually working already. In attempts to advance carbon neutral development in synergy with SDGs, if a carbon neutrality strategy based on GNH were to be successful, a new development pathway that does not adhere to the type of development followed by developed nations would become available to other developing countries.

This research, based on IGES and NIES cooperation with RUB/iGNHaS, will examine the feasibility of adopting policies based on multidimensional development goals by including policies that incorporate elements of GNH into the creation of carbon neutral scenarios and assessing their effectiveness.

Land use planning to protect natural resources via GNH regional community decentralisation policy



Natural resources are attached to land and widely dispersed. They degrade when neglected and will impact climate change in the future. In order to protect natural resources, every community requires people that protect the natural resources to live there. In particular, enhancement of absorption for carbon neutrality requires community residents that preserve forests and soil while using them appropriately for agriculture and forestry. However, the trend of population concentration in urban areas has

not ceased for any country as it develops. The Bhutan government has put in place regional decentralisation policies to maintain distinctive local culture and protect traditions. While these policies are also reflected in budget allocation, appropriate national land use planning is required. At present, JICA is preparing a national comprehensive development plan, and IGES, in cooperation with MoWHS, will contribute expertise from the perspective of carbon neutrality.