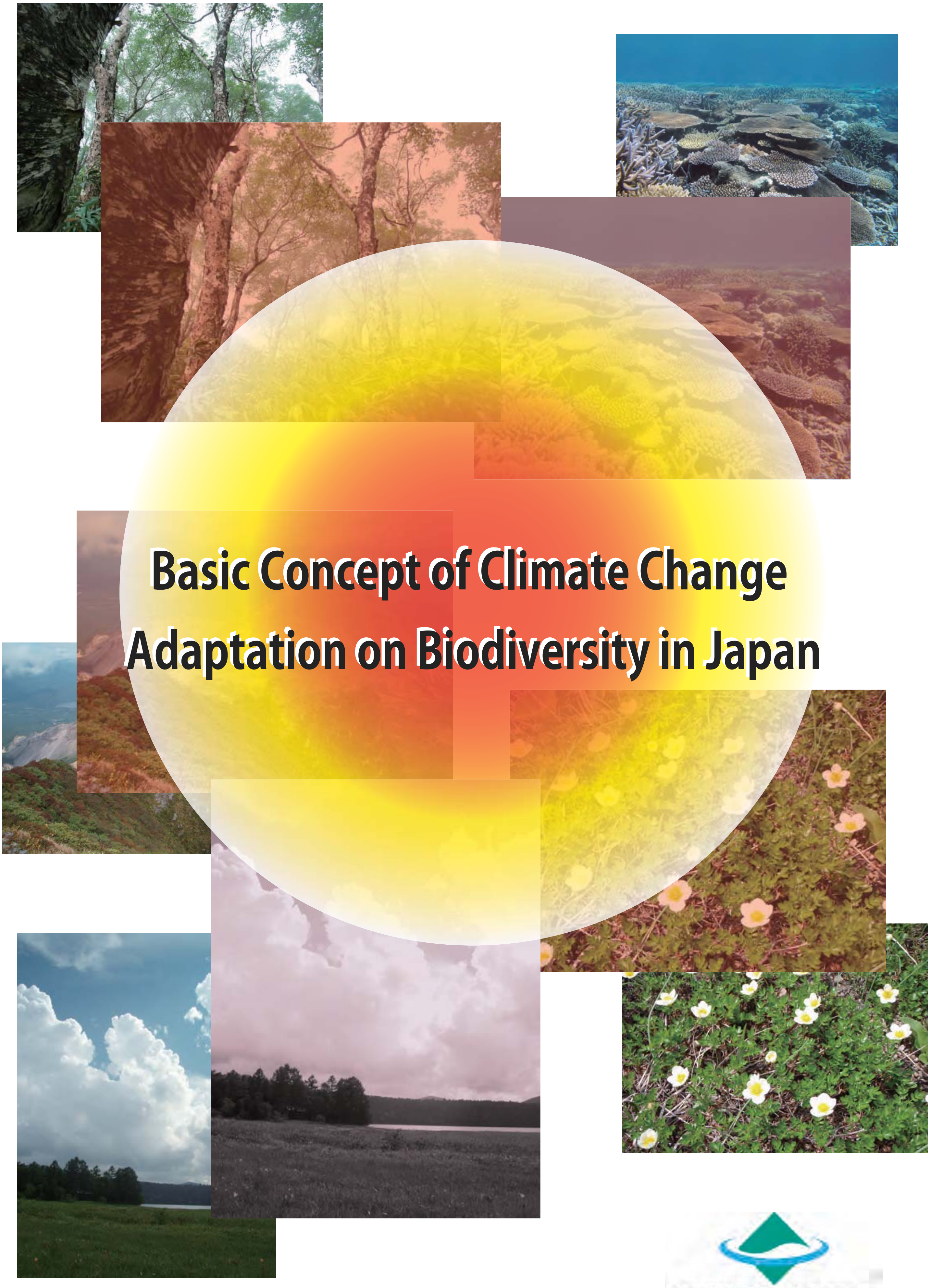
Basic Concept of Climate Change Adaptation on Biodiversity in Japan

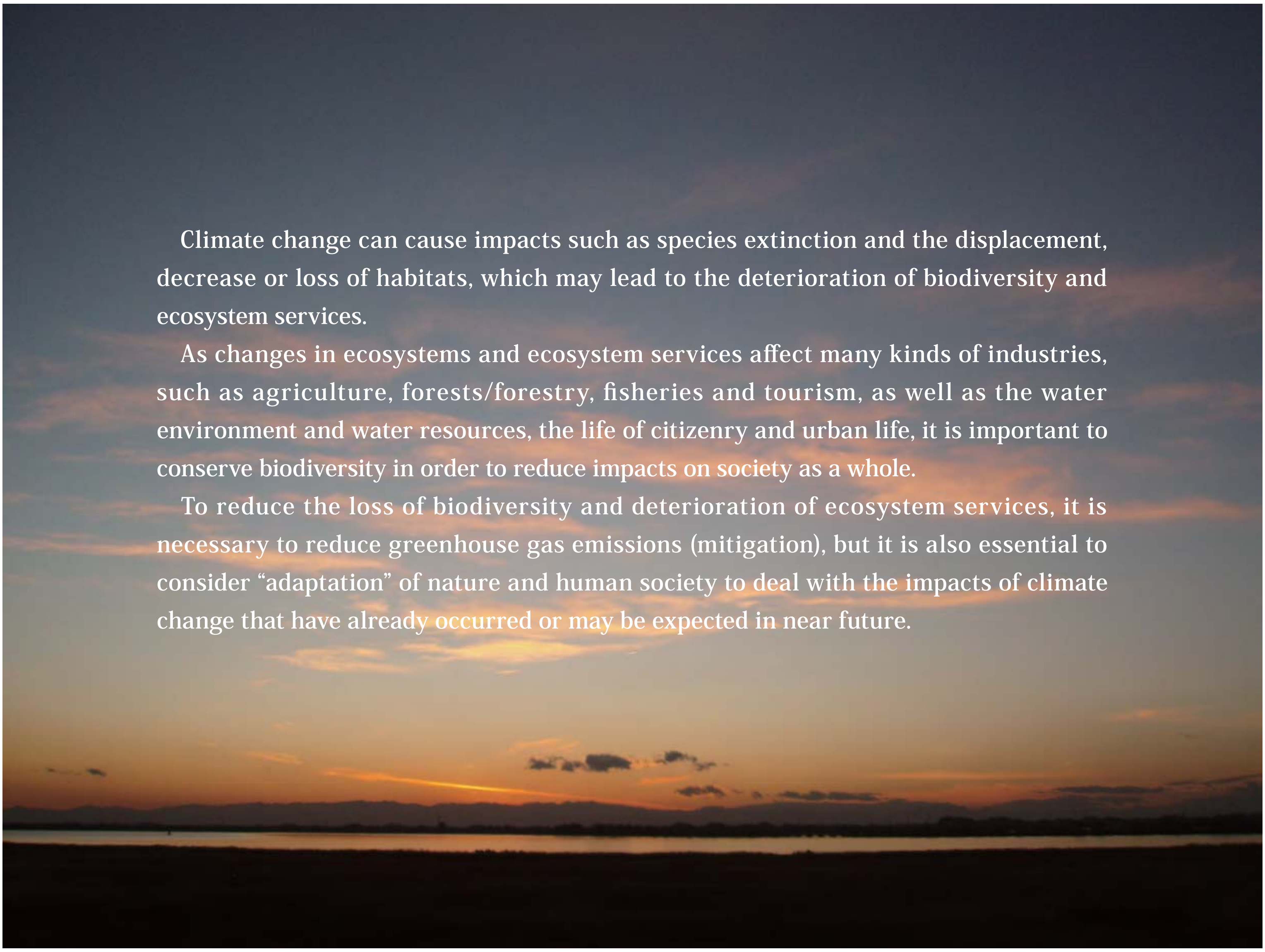


Ministry of the Environment
Government of Japan

Climate change can cause impacts such as species extinction and the displacement, decrease or loss of habitats, which may lead to the deterioration of biodiversity and ecosystem services.

As changes in ecosystems and ecosystem services affect many kinds of industries, such as agriculture, forests/forestry, fisheries and tourism, as well as the water environment and water resources, the life of citizenry and urban life, it is important to conserve biodiversity in order to reduce impacts on society as a whole.

To reduce the loss of biodiversity and deterioration of ecosystem services, it is necessary to reduce greenhouse gas emissions (mitigation), but it is also essential to consider “adaptation” of nature and human society to deal with the impacts of climate change that have already occurred or may be expected in near future.



Sunset of Watarase Yusuichi

contents

Impacts of Climate Change – Change of Climate Elements –

Observations and Forecasts of Climate Change

Note: References in this pamphlet to the impacts of climate change are based mainly on the "Report on Assessment of Impacts of Climate Change in Japan and Future Challenges (Comment Submission)" (March 2015, Central Environment Council).

Current Greenhouse Gas Emissions

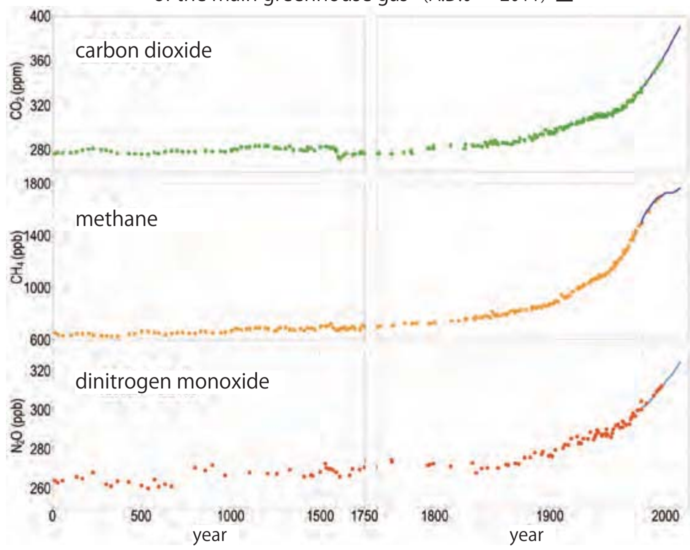
According to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), atmospheric concentrations of carbon dioxide, methane and nitrous oxide (greenhouse gases that affect climate change) have increased to levels unprecedented in at least the past 800,000 years, and the increase has been shown to be entirely attributable to human activities since 1750.

Carbon dioxide concentrations have also been increasing year after year, with the monthly average concentrations exceeding 400 parts per million (ppm) in 2013 for the first time at all greenhouse gas monitoring stations in Japan.

【Projections】

Simulations used in the IPCC's Fifth Assessment Report were conducted under four scenarios (see note) based on predefined conditions for concentrations or anthropogenic emissions of greenhouse gases. In the various scenarios, future atmospheric concentrations of carbon dioxide were defined to reach between 421 ppm (RCP2.6) and 936 ppm (RCP8.5) by 2100.

■Changes in the concentration in the atmosphere of the main greenhouse gas（A.D.0～2011）■



Source：Japan Meteorological Agency website

Note: Representative Concentration Pathways (RCP) scenarios: Four scenarios based on greenhouse gas concentrations, ranging from RCP2.6 (low emission mitigation scenario) to RCP8.5 (high emission scenario).

Atomospheric Temperature

The global annual mean temperature has been increasing while fluctuating, with a rate of increase of 0.69℃ per 100 years. The rate of increase in annual mean temperature in Japan from 1898 to 2013 was 1.14℃ per 100 years (1.15℃, 1.28℃, 1.05℃, and 1.19℃ for winter, spring, summer and autumn, respectively).

In the period 1931 to 2013, the number of days with maximum temperatures of 30℃ or higher shows no discernible trend, but the annual number of days with maximum temperatures of 35℃ or higher have clearly increased. In addition, the number of days with minimum temperatures of 25℃ or higher has increased, while the number of days with minimum temperatures below 0℃ has decreased.

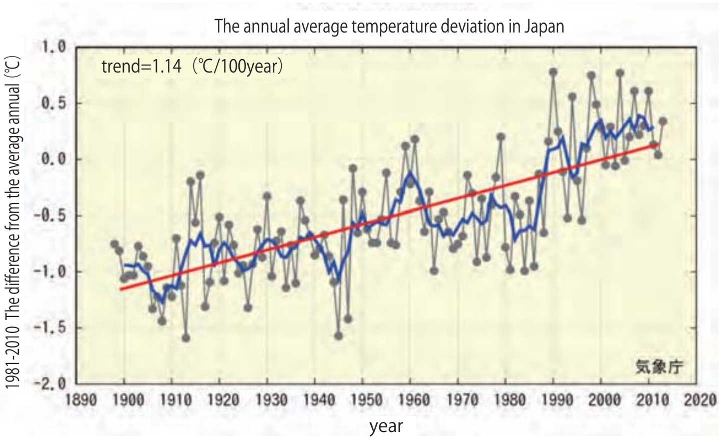
【Projections】

〇Annual mean temperature will increase, with more increase at higher than lower latitudes, and in winter more than in summer.

〇The number of hot days and hot nights will increase, and the number of the cold days will decrease.

〇Relative to the end of the 20th century, by the end of the 21st century, the annual mean temperature in Japan has been projected to increase by an average 1.1℃ (0.5–1.7℃ with a 90% confidence interval) in the case of RCP2.6, and an average 4.4℃ (3.4–5.4℃ with a 90% confidence interval) in the case of RCP8.5.

■Secular change of the annual average temperature in Japan（1898～2013）■



The thin line (black) shows the mean value of deviation from the reference value of annual mean temperature at 15 observation points in Japan. The thick line (blue) shows the 5-year moving average of deviations, and the straight line (red) shows the long-term trend. The reference value is the average for the period 1981 to 2010.

Source：Climate change monitoring report 2013, Japan Meteorological Agency

Precipitation

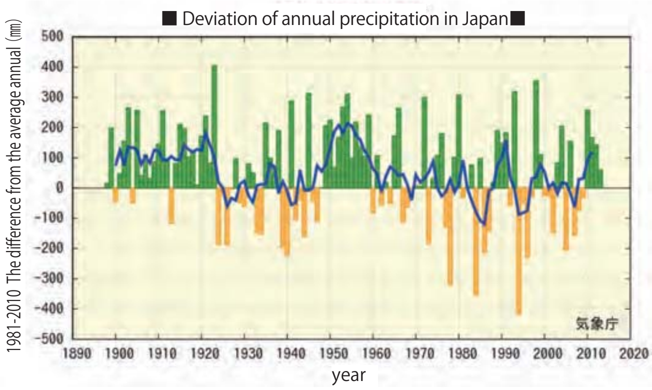
For annual precipitation, no long-term trend is evident for the period 1898–2013, but Japan experienced relatively large amounts of rainfall until the mid-1920s, and around the 1950s, and the annual figure has become more variable since the 1970s.

It is extremely likely that the annual number of days with precipitation of at least 100 mm and at least 200 mm has increased from 1901 to 2013. On the other hand, the annual number of days with precipitation of at least 1.0 mm has decreased, suggesting a decrease in the annual number of wet days including light precipitation and in contrast, an increase in extremely wet days.

【Projections】

○Relative to the end of the 20th century, the frequency of heavy rainfall, short-term intense rainfall and number of dry days (with less than 1.0 mm of precipitation) will increase.

○The northward shift of the Baiu seasonal rain front will be delayed, the end of the Baiu will be delayed.



The bar graph shows the average deviation (from the average of 1981 to 2010) of annual precipitation at 51 monitoring stations in Japan, and the blue line shows the five-year moving average of deviation.

Source：Climate change monitoring report 2013, Japan Meteorological Agency

Typhoons

During period from 1951 to 2013, more years are showing a small number of formations of tropical cyclones (typhoons) since the late 1990s, although there is no discernible long-term trend. Since 1977 when the collection of complete data on maximum wind speed near tropical cyclone centers began, no trend is shown in the incidence of strong or more intense tropical cyclones, and for the numbers of formations.

【Projections】

○Extremely strong tropical cyclones may increase in Japan' s southern seas, and they may reach the vicinity of Japan while maintaining their relative strength.

○An increasing trend is projected relative to the present in the number of occurrences of strong tropical cyclones, the maximum intensity of tropical cyclones, and rainfall intensity at the time of maximum tropical cyclone intensity. Meanwhile, the number of occurrences of tropical cyclones in the western Pacific is projected to decrease slightly in the long term.

Snow Cover and Snowfall

A downward trend in annual maximum snow depth has clearly emerged for the period 1962 to 2013 on both the eastern and western sides of the Sea of Japan, but no trend has been observed in northern Japan facing the Sea of Japan. The annual maximum snow depth is subject to large annual variations and the period covered by observational records is still relatively short, so there is a need to collect more data in the future.

【Projections】

○Snow depth and snowfall will decrease mainly on the Sea of Japan side of eastern Japan, but both will increase in some inland areas of Hokkaido.

○ The snowy season will be shorter (beginning of the season will be later, and end will be sooner).

Oceans

The rate of increase of sea surface temperature (annual mean) in Japanese coastal waters was +1.08° C/100 years over the period of about 100 years until 2013, and this rate is higher than for the North Pacific Ocean overall (+0 .45°C/100 years).

While sea levels along the coast of Japan do not exhibit a clear long-term upward trend since 1906, a clear upward is evident since 1960 when the current observation regime began.

【Projections】

○Sea surface temperature around Japan will increase in the long term, and a greater increase is expected in the Sea of Japan than in Japan' s southern waters.

○Even if measures against global warming are conducted, the global mean sea levels are expected to continue rising during the 21st century.

Sea Ice

According to observations from 1971 to 2013, while there is a large annual variation in the accumulated sea ice extent (an index representing the potency of sea ice), the index for the Sea of Okhotsk has decreased at a rate of 1.75 million km^2 per decade, and the maximum sea ice extent has declined at a rate of 58,000 km^2 per decade (equivalent to 3.7% of the total area of the Sea of Okhotsk).

【Projections】

○The sea ice extent in the Sea of Okhotsk from January to April and the maximum sea ice extent observed around March are both expected to decline by approximately 75% relative to the end of the 20th century.

○ Freezing will begin later in late autumn, and the sea ice retreat northward in spring will be earlier.

Impact on Natural Ecosystem < Existing Impact >

Changes to natural ecosystems due to the impacts of climate change have appeared in many regions of the world, and in Japan as well, observations have already included changes in vegetation, expanded distribution of wildlife, and coral bleaching, etc. The impacts are expected to expand in various regions of Japan in the future.

Terrestrial Ecosystems

■Alpine and Subalpine Zone

There have been reports of decline and distribution changes of vegetation due to factors such as increased temperature and earlier snow melt.

In addition, gaps have been reported between of timing of activity periods of pollinator insects due to early flowering or shorter flowering periods of alpine plants.

■Vegetation changes in a wet meadow of Daisetsuzan Goshikigahara (elevation 1,750 m)■

A variety of Anemone narcissiflora ("ezonohakusan ichige" in Japanese, in the buttercup family) flourished here until the first half of the 1990s, but it later declined and the area has turned into a grassland dominated by grass species (Gramineae).

Source：Yuka KAWAI and Gaku KUDO (2014), Current changes in alpine vegetation and their impacts on biodiversity in the Daisetsuzan National Park, Global environment Vol.19 No.1 23－32（2014）

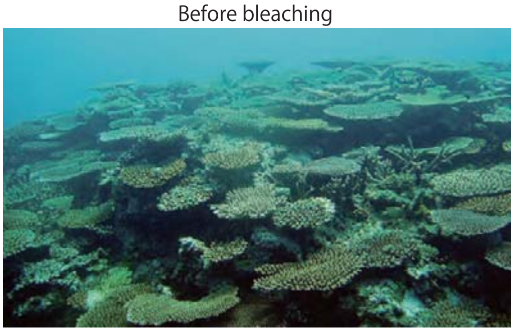
Coastal Ecosystems

■Subtropics

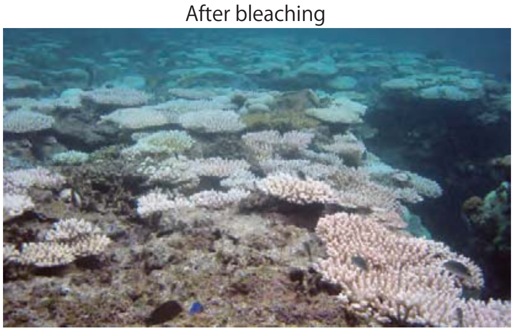
Coral bleaching has been observed in sub-tropical regions, caused by the loss of symbiotic algae due to stresses such as increased water temperature; if those conditions persist, the coral dies, unable to obtain nutrients from symbiotic algae. In the Okinawa region, the frequency of bleaching of subtropical corals has increased due to increasing sea temperatures.

The distribution of the temperate coral has been expanding northward in the Pacific Ocean in areas south of the Boso Peninsula and along the west and north coasts of Kyushu .

Before bleaching



After bleaching



Source：Ministry of the Environment

Phenology

A number of reports have been confirmed about changes in the phenology of plants and animals, including earlier flowering of plants and earlier initiation of calling by pollinators.

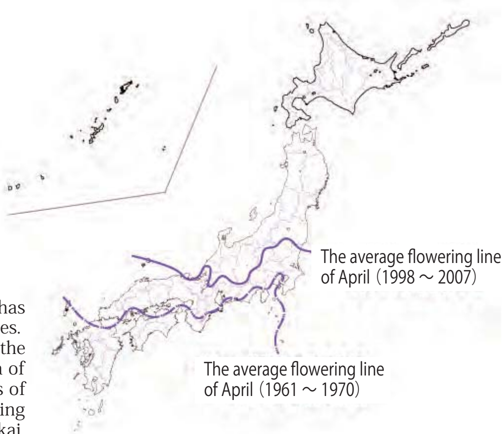
Prunus nipponica var. kurilensis

Bombus hypnorum koropokkrus and *Campanula lasiocarpa*

For many years, earlier flowering of cherry blossoms has been observed, due to changes in early spring temperatures.

In the 1960s, cherry blossoms were open on April 1 in the area between the Miura Peninsula and the Kii Peninsula of Pacific coast of the island of Honshu, and on the islands of Shikoku and Kyushu. In the past ten years, however, during the same period the blossoms now open in the Kanto, Tokai, Kinki and Chugoku regions. (April 2014)

■Changes in flowering line of April 1 of Cherry Blossoms (Somei- Yoshino)■



Source：Japan Meteorological Agency website

Impact on Natural Ecosystem < Predicted Impact >

While the relationship to climate change differs depending on what is being observed, as well as conditions, the range, and other factors that influence the impacts of climate change, a variety of have been predicted for the future.

Terrestrial Ecosystems

■Alpine and Subalpine Zone

Some predictions include changes or reductions in suitable habitat for plants such as Siberian dwarf pine("haimatsu" in Japanese), the disappearance of populations of alpine plants due to earlier snow-melt, and changes in vegetation succession due to temperature increases in growing season, resulting in the spread of shrub plants.

■Natural and Secondary Forests

It is expected that tree species will move to higher latitudes and elevations, and suitable habitats for species of cool temperate forests (beech etc.) are expected to decrease, while habitats for species of warm temperate forests (Japanese evergreen oak etc.) are expected to increase.

■Satochi-Satoyama Areas

There may be only small impacts of climate change in natural grassland vegetation zones in the warm temperate zone or further south, but suitable habitat of secondary forests of "satoyama" (Secondary Natural Environments) including some kinds of hornbeam ("akashide" and "inushide" in Japanese) may shrink in low mountain elevations and in southwest Japan.

■Planted Forests

Particularly in areas with low precipitation, greater vulnerability of cedar tree plantations has been projected due to an increase in annual transpiration if temperature increases by 3℃ above the current level. An expansion of the area at risk of pine wilt disease has been projected if the temperature increases by 1 to 2℃ above the current level, and there are concerns that along with pine wilt, there could also be damage to areas engaged in Japanese red pine("akamatsu" in japanese) forestry and that produce pine mushrooms ("matsutake" in japanese).

Cervus nippon

Fagus crenata

■Damage from Wildlife

Associated with expanded distribution of wildlife such as the sika deer (*Cervus nippon*) due to increased temperatures and a shorter snowy season, an increase in ecosystem impacts is expected, such as soil runoff, a decline in watershed conservation capacity, and landscape degradation, caused by the loss of understory vegetation and tree death due to foraging, bark stripping damage, and ground trampling.

■Material Balance

Increases in temperature and a lengthening of rainless periods may result in the reduction of moisture content in forest soils, leading to drying of surface soil, then more runoff of fine sediment and prolonged time to reduce turbidity, and ultimately, to shorter rainfall-runoff response times
In addition, changes in carbon stocks in forest soils are expected.

Marine Ecosystems

Variations in phytoplankton biomass may occur due to the climate change, with decreases expected globally in tropical and subtropical waters, and increases in sub-arctic waters.

Freshwater Ecosystems

Lakes and Marshes

In deep lakes and marshes where eutrophication is occurring, a climate change-induced increase in water temperature may weaken the vertical water circulation, reduce dissolved oxygen at the bottom, and promote oxygenation deficiency. Deoxygenation of lakes and marshes has impacts on shellfish and other benthic organisms and can accelerate eutrophication.

Laboratory experiments have shown that increases in lake water temperature and CO_2 concentrations reduce the growth of zooplankton.

Rivers

If the maximum water temperature increases by 3℃ above current levels, the total area of rivers in Japan that can support cold water fish is expected to decrease from about 40% to about 20%.

There are also concerns about impacts on the river organisms due to changes in the timing and snowfall and snowmelt flood, changes of the riverbed environment by increased frequency of large-scale floods, and water temperature increase and dissolved oxygen decrease caused by drought.

Wetlands

While a decrease in average soil moisture content is expected, more stored carbon could be released into the atmosphere when an aerobic environment is formed by the lowering of groundwater levels, and accumulated organic matter is decomposed. In addition, sediment and nutrient inflows are expected to result in a transition from wetland herbaceous communities in low elevation wetlands to woody plant communities, with further increases in evapotranspiration.


Oze National Park

Phenology

Impacts for a variety of species are projected as a result of changes in phenology, such as earlier flowering of the Yoshino cherry tree(“someiyoshino” in japanese). The impacts are not limited to individual species, but are also expected to affect various interactions between species, including the failure of pollination due to a shift in pollinator activity period versus the timing of plant flowering.

Coastal Ecosystems

Subtropics

Bruguiera gymnorhiza

Water temperature increases and ocean acidification are expected to result in a decrease or loss of suitable seas for reef-building corals in tropical and subtropical areas, as well as increased stress from bleaching, etc., and a reduction in the amount of calcification.
Impacts are also expected for tourism resources and fisheries resources in regions with coral reefs. In addition, habitat reduction is expected in mangroves, due to sea-level rise.

Temperates and boreal

Increasing sea temperatures are expected to result in a transition to warm-water species. Ocean acidification is expected to affect calcification processes (calcium carbonate skeletons and shells) in reef-building corals, shellfish, and sea urchins, etc., with possible negative impacts on fisheries resources. In addition, there are concerns that sea-level rise could cause the erosion of tidal flats and the loss of salt marshes.

Shifts in Distribution and Populations

In addition to changes in species distribution and life-cycles due to climate change, other projections include species extinctions due to the lack of capacity to migrate to keep up with climate change, as a result of changes in inter-species interactions caused by the migration of the species, localized extinction, and the fragmentation of the habitats.
It has been shown that many species will be unable migrate to suitable habitats and environments in the case of medium to high emission scenarios of greenhouse gas emissions (RCP4.5 to RCP8.5), as their speed of migration will be unable to keep up with the rate of change of temperature.

Also, the rate of invasion and establishment of invasive alien species is expected to increase.


Drocera anglica


Anas platyrhynchos

◇ Impact of climate change has been found in the monitoring site 1000 ◇

Japan has produced a diversity of flora and fauna, with its land area consisting of large and small islands spanning from the sub-arctic to sub-tropical regions, its topography varying considerably, undulating mountains and coastlines rich in variety, and many localized climate features.

To monitor the diverse ecosystems on the Japanese archipelago, the Ministry of the Environment established about 1,000 monitoring sites across the country and has continued for many years to collect basic environmental information. As a result, since an early stage, it has been aware of the qualitative and quantitative deterioration of Japan’s natural environment.

[Alpine Zone] At five monitoring sites, parameters being monitoring include air temperature, soil temperature, land surface temperature, vegetation, annual branch growth of Syberian dwarf pine, and flowering phenology, etc. There has increase in the annual branch growth of Syberian dwarf pine (a parameter that has a high correlation with summer temperatures), and measurements indicate that summer temperatures may have risen in the past 20 years.

[Vegetation Surveys] Monitoring is being conducted around snowy valleys (which are sensitive to the impacts of environmental changes), with an emphasis on snowbed vegetation, windswept shrub and grassland areas, and solfatara vegetation. It is thought that compared to windswept areas, snowbed environments reflect snow cover’s impact on moisture conditions and protection from drying, so snow cover changes could affect snowbed environments.

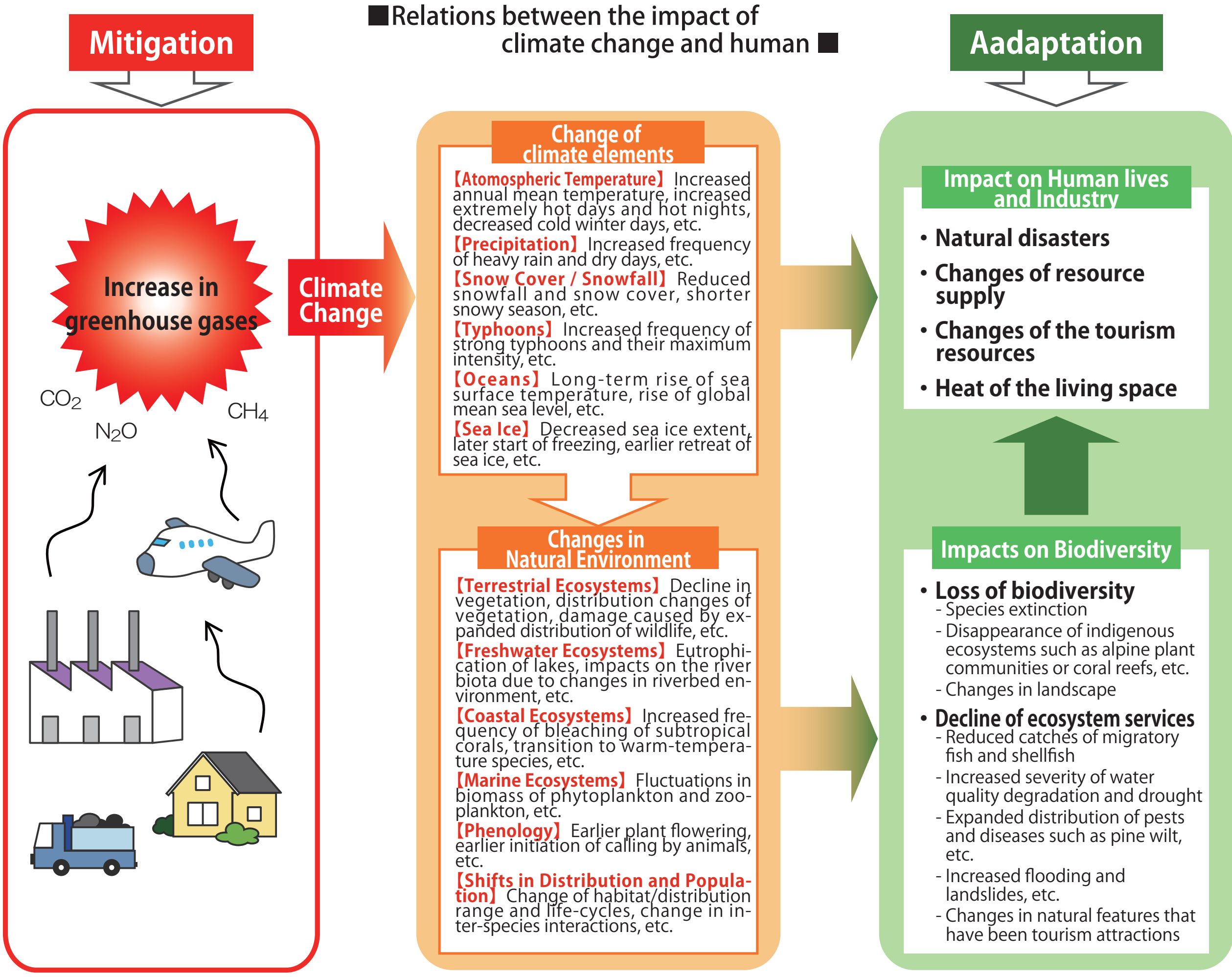
In addition, at the summit of Mount Fuji, seed plants have been observed that were not previously present, and mosses whose growth is affected by permafrost have been in decline.

Climate Change Adaptation on Biodiversity

Features of Impacts on Biodiversity

Changes in environmental conditions such as temperature and precipitation, which determine the basic parameters for living things, will lead to changes in entire ecosystems. The extent and the timing of impacts will vary with differences in region, species, ecosystems, and other factors. Climate-change-induced impacts on ecosystems will have a high degree uncertainty, when one considers the many factors involved, so there will also be uncertainty for impacts on "ecosystem services" (the benefits obtained by humans from the diverse biota of an ecosystem). There is still a lack of adequate knowledge regarding the impacts of climate change on humanity through ecosystems.

■Relations between the impact of climate change and human■



Importance of Monitoring, Research and Technology Development

It is necessary to correctly grasp changes in ecosystems caused by climate change and take measures based on future prediction. However, because the impact of climate change is highly uncertain and progresses for a long period of time, it will take time before the appearance of a clear change in the distribution and population of species, ecosystem services, etc.

Therefore, there is the urgent need to expand monitoring to grasp the impact of climate change. It is necessary to design monitoring to enable detection of the impact of climate change and use of the results for countermeasures. It is also necessary to grasp the actual situation of ecosystems, identify areas especially vulnerable to climate change and less-vulnerable stable areas, etc. and to implement monitoring focusing on them. In terms of species, it is necessary to identify vulnerable species and the areas to which organisms will flee when temperature rises, and focus on their monitoring for the purpose of their conservation.

Existing research and technology development are not sufficient for monitoring and assessing the impact of climate change on biodiversity and ecosystem services nor are techniques to plan and implement adaptation activities. It is necessary to further promote such research and development. Knowledge is especially insufficient in the area of the impact of change in biodiversity on ecosystem services. This is a research task that needs focused efforts.

Basic Concept of Aptation

- It is impossible for humans to exert broad control on ecosystem changes, because changes occur to entire ecosystems in response to climate change.
- Try to maintain and restore sound ecosystems with resilience to climate change by reducing non-climatic stresses and building ecosystem networks
- Grasp the change in ecosystems and species through monitoring

Perspectives of Adaptation on Biodiversity

The need of adaptation activities to reduce the adverse impacts of climate change on biodiversity	☞ P. 9-12
Prevention of the potential impacts on biodiversity caused by broader adaptation activities	☞ P.13-14
The use of biodiversity and ecosystem services as part of an overall adaptation strategy	☞ P.15-16

Incorporation of Climate Change Impacts in Nature Conservation Measures

Incorporation of climate change impacts in nature conservation measures	It is necessary to consider the impacts of climate change in planning measures related to the natural environment including park planning and management/operating plan of national parks, assessment of red list species and invasive alien species. When next reviewing management/operating plans , it is necessary to check their goals and measures considering the impacts of climate change, while at the same time examining the need of monitoring to grasp relevant indices.
Adaptive management approach	It is important to reduce the uncertainty of the impact on biodiversity and accompanying impact on ecosystem services by enhancing knowledge. In practice, it is important to adopt an adaptive management approach with evidence based on predicted results through prior investigation, and also carry out monitoring and scientific assessment of the results after starting the project in order to improve the project.
Consensus building, role sharing and coordination/cooperation among stakeholders	First, it is important to select a policy of adaptation measures in terms of target ecosystems and ecosystem services, and desirability of active intervention, for example. Consequently, it is necessary for diverse players, including national administrative organs concerned, local governments, local residents, NGOs, NPOs, and people with expertise in the natural environment, to cooperate in planning and implementing comprehensive adaptation measures by sharing information, building full consensus and sharing roles.
Sharing information	The impact of climate change on biodiversity will widely affect the public. For this purpose, it is important to share information and raise public awareness of the current status of the impact of climate change on biodiversity, future prediction including uncertainty, direction and current situation of efforts, effects and limitation of adaptation measures and other issues.
Human resource development	Because human resources play important roles in the appropriate and effective implementation of adaptation activities, it is necessary to develop human resources from a long-term perspective.

Adaptation Activities to Reduce Adverse Impacts of C

① Conservation and Restoration of Sound Ecosystems with Good Adaptability to Climate Change

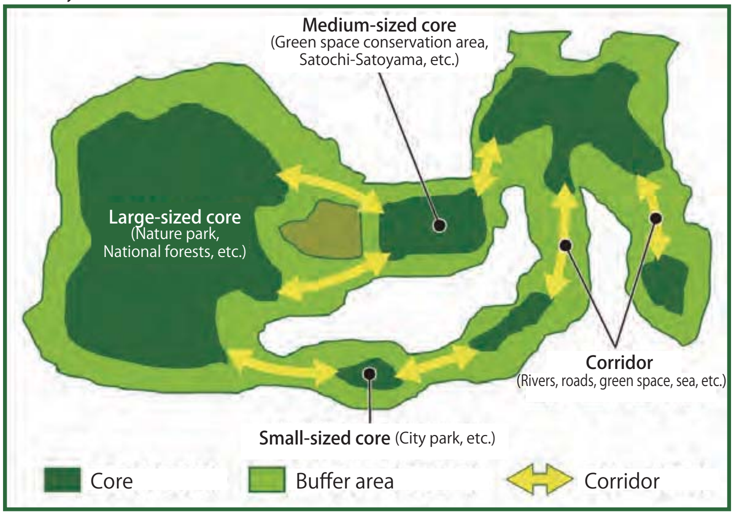
The fundamental point of adaptation measures on biodiversity is to conserve or restore sound ecosystems with good adaptability to climate change by reducing stresses caused by factors other than climate change, while at the same time building ecosystem networks. Because the measure contributes also to conservation of current biodiversity, the adaptation measure can be implemented even when future impacts are uncertain.

Maintaining or restoring sound conditions	It is important to reduce development, environmental pollution, overuse, invasion by non-native species and stresses other than climate change.
	It is important to identify and preferentially conserve areas less vulnerable to climate change and those that can serve as a refuge when climate changes occur.
	It is necessary to further promote existing measures for the conservation of biodiversity taking into account the expected impact of climate change. Such measures include: review and adequate management of national/quasi-national parks and other protected areas, population control of deer and other wild animals whose population has increased and had a serious impact on ecosystems, control of and border control against alien species, protection and propagation of rare species.
	The restoration of nature to retrieve damaged ecosystems and other natural environments promises effects to enhance the adaptability of ecosystems and species to climate change.
Building ecosystem networks	It is important to secure routes for organisms to migrate and disperse in response to temperature rise and other environmental changes.
	It is necessary to promote the formation of ecosystem networks by expanding or connecting protected areas and regenerating nature to eliminate the division of ecosystems.
	Considering prediction of the social environment, it is effective to restore natural conditions in areas that are difficult to maintain due to population decline, etc. to use as protected areas or a part of an ecosystem network.

In addition to enhancing ecosystems adaptability to climate change, ecosystem networks are expected to fulfill multiple functions including securing habitats for wildlife, providing good landscapes and places for people to experience nature, improving urban and water environments, and conserving national land.

Vulnerability and adaptive capacity to the impacts of climate-change vary with each species and ecosystem. For this reason, it is important to ensure that a variety of species and ecosystems will be able to respond broadly to change, and adapt to climate change over time. For example, it will be important to take measures such as the creation of networks of ecosystems that have a certain degree of consolidation in order to maintain connections between core areas of unaltered natural forests and their surrounding areas.

■Ecosystem network■



Source：Challenge of adaptation to protect Japan from global warming 2012, Ministry of the Environment

Climate Change Adaptation Case Study in New Forest National Park (United Kingdom)

New Forest National Park is a new park in southern England that consists of coasts and lowlands, with an area of about 570 square kilometers (designated a national park in 2005). The grasslands have been used as rangeland for cattle and horses. This is a natural environment that has been formed by the collaboration of nature and people over time.

However, construction work in the 1800s and 1950s destroyed the wetlands of the New Forest area, and smaller creeks were also cut off from the main streams. This resulted in significant impacts on living organisms, and a loss of biodiversity.

Furthermore, changes in creeks created artificial flow paths, resulting in erosion of sediment in the upstream areas of the wetlands. The resulting flow rates and riverbed structure were unsuitable as habitat for invertebrates, and the adaptability to climate change declined.

A scene from within a park. Horses and cows graze here, so the area is not highly natural, but it is still a unique landscape.

Restored stream flowing through grassland. Shallows and edges are formed at the relatively large meandering sections（Fletchers Thorns）.

However, things began to improve with efforts to restore the river functions when streams were realigned in 2011.

In restoration processes, artificial terrain modifications were avoided as much as possible, and an emphasis was given to the natural terrain that would be formed by river flow. Accessible and low-risk environments for people and animals in the area have been produced by creating areas with slow-flowing and shallow water. Since the stream restoration, positive changes have been observed in plant communities, seasonal flooding occurs along creeks, and habitats in the floodplain have returned to a more natural state. Seasonal flooding is a natural phenomenon, and in the future, it is expected that this region will return to natural grassland with higher diversity.

The realigned stream is more hydrologically stable, and the restoration has promoted natural processes and ecosystem functions, which can also be seen as benefits in terms of climate change adaptation.

Advice from the UK government encourages direct management to reduce impacts, including:

- Promote dispersal of species.
- Increase available habitat.
- Promote conditions for natural ecosystem functioning.
- Optimise individual response to climate change for biodiversity.
- Continue to reduce pressures not linked to climate change.

Source：Reviving the river-river restoration Case Studies of Japan and the world -（Japan River Restoration Network、Foundation for Riverfront Improvement and Restoration）
Cooperation of coverage：New Forest National Park Authority

Case study that can be the adaptation measures

- Planting of beech and other broad-leaved trees, and work to augment natural re-seeding in order to create an ecosystem network of continuous forest.
- Installation of protective fence to prevent feeding damage from deer, in order to restore forest floor vegetation and protect rare plants.
- Installation of equipment that removes seeds attached to shoes, in order to prevent alien plants from spreading to the core section of a natural park.
- Implementation of pest control measures for alien species, in order to conserve or restore sound ecosystems.
- Improvement of water quality, prevention of land, and restoration of submerged plants, in order to conserve and restore a lake ecosystem.
- Formation of a tidal flat environment and conservation of remaining wetland, in order to conserve or restore tidal flats and shallow waters.

Dropping the seeds attached to the shoe sole in the Oze National Park

② Active Intervention

The failure of an ecosystem to keep up with the pace of climate change, stress due to other factors, and the division of an ecosystem that blocks migration and dispersion of organisms, for example, might lead to a decrease in symbolic species, loss of excellent natural landscape, deterioration of ecosystem services supporting people’s lifestyles, and other problems.

Similar problems might occur also when ecosystems have adjusted to climate change if the current ecosystems and ecosystem services are lost in this process.

If such problems are significant, active intervention may be conducted, including management to maintain existing ecosystems and species, such as mowing and improvement cutting; ex situ conservation, such as conservation in zoos, botanical gardens, etc.; and management conductive to adaptation to climate change, such as translocation of individuals to a new suitable habitat.

It is necessary to decide the policy based on the consensus of stakeholders from the perspective of the conservation goals, advantages and disadvantages of the intervention in terms of the impact on the ecosystem and ecosystem services, existence of other effective measures, feasibility of the project and relative costs and benefits.

Management to maintain existing ecosystems and species	For key landscapes of national parks, the maintenance of which is desirable, the removal of invading plants and restoration of vegetation to maintain alpine plant communities and other measures to control change may be considered.
	In order to maintain the currently inhabiting species, you may consider the reintroduction of species that have become extinct or are in danger of extinction in the region and the addition of individuals of the species whose population has decreased in the habitat.
	You may also consider installing fences or cages in a habitat to reduce the impact of feeding or predation by species that have increased or invaded the habitat as a result of climate change.
Ex situ conservation	If it is deemed difficult to conserve species in their current habitat, you may preserve them in zoos, botanical gardens, etc. However, it is necessary to carefully examine the meaning of such conservation, considering that it might become difficult to return them to nature due to the loss of their habitat and that you might need to secure a budget, etc. on a long-term basis.
Management conductive to adaptation to climate change	If communities do not change soundly because of a loss of some species due to slow speed of travel, divided ecosystem, and other reasons, you may consider reconstruction of the ecosystem involving artificial translocation.
	When the risk of extinction is increasing for certain species that cannot migrate or disperse because they are distributed in isolation at high altitudes or their habitat is artificially divided, for example, you may consider conservation introduction to other suitable habitats in addition to ex situ conservation. However, you should be very careful because they will be alien species in the area where they are introduced.

Examples of active intervention

【*Sasa kurilensis* cutting experiments in Daisetsuzan Goshikigahara】


Before cutting（2008）

Thick growth of running bamboo (“sasa”) 70 cm at least in height or before cutting.


After one year（2009）

Almost no other plants grew here the year after cutting.


After 5 years（2013）

Thereafter, vegetation recovered quickly, with significant recovery observed in five years (yellow flower are *Trollius riederianus*).

Source：Yuka KAWAI and Gaku KUDO (2014), Current changes in alpine vegetation and their impacts on biodiversity in the Daisetsuzan National Park, Global environment Vol.19 No.1 23−32（2014）

Ex-situ Coservation of Crop Wild Relatives (CWR※)

Fifty years ago, during the 1970's, rice yields across much of South East Asia suffered severe losses. The cause was Rice Grassy Stunt Virus, which was spread by brown planthoppers. The virus wreaked havoc on the rice cultivars grown by most farmers, leading to the destruction of more than 116,000 hectares of fields. Crop breeders tried in vain to screen resistant genes in more than 6,000 varieties of both cultivated and wild rice. Finally, this vital trait was discovered in a single wild relative of rice, *Oryza nivara*.

Crossing *O. nivara* with domesticated *O. sativa* allowed the transfer of Rice Grassy Stunt Virus resistance, ensuring rice production quickly recovered.

Crisis duly averted. Or merely postponed? Fast forward to today, and a planet of 7 billion people consumes 80% of its calories from just 12 plant species, with 50% coming from just three – wheat, maize and rice. These crops are now at risk from changes in climatic conditions and the diseases resulting from increased temperatures.

This is why the Millennium Seed Bank is helping partners to track down and conserve the wild relatives of our most prized crop plants. Although many crop wild relatives look like weeds, they are just what they sound like – rugged, hardy cousins to our more pampered domesticated crop plants. They are diverse, used to living in marginal conditions and fighting off disease, yet still hold vital adaptive genes, which have been bred out in modern agriculture. In the years to come, crop breeders will come to rely on reuniting these long lost family members.

The Project funds four primary activities: CWR prioritization, collection, conservation, and pre-breeding work to prepare CWR genetic material for use in breeding programs. The Project's activities are focused specifically on collecting and conserving the wild relatives of 29 focal crops, and launching pre-breeding projects for 20 of these crops.

Riped paddy field rice

Source：Oyama city

※Crop Wild Relatives: Many food crops have been developed by breeding from wild species, which still have genes similar to these crops as they were prior to breeding. These are called "Crop Wild Relatives."

Source：Excerpted from "The Role of Crop Diversity and Food Resilience in a Changing Climate Symposium"
http://www.cwrdiversity.org/one-day-symposium-at-kews-millennium-seed-bank-november-23-2015-the-role-of-crop-diversity-and-food-resilience-in-a-changing-climate/

Case study that can be the adaptation measures

- Cutting and removal of running bamboo ("sasa") etc., which expands distribution with growth, in order to conserve the alpine vegetation zone.
- Cutting of lotus and reed to inhibit the growth of emergent plants and floating-leaved plants, in order to restore these plants, which were significantly reduced by heavy rains.
- The coral transplantation and growth at the artificial reef for the purpose of the recovery of reduced coral by bleaching.
- In situ protection by cage, in order to increase survival rate of rare birds after hatching.
- Conservation of species by the ex-situ growth under the cultivation at the zoo or botanical garden for the purpose of conservation of the species.

Cutting and removal of running bamboo ("sasa")

Minimizing the Impact of Broader Adaptation A

Some adaptation activities taken in other sectors may have a favorable impact on biodiversity and ecosystem services, but others may have an adverse impact.

To ensure that adaptation decisions maximize favorable impacts and minimize adverse impacts on biodiversity, the Secretariat of the Convention on Biological Diversity (SCBD) recommends the following principles.

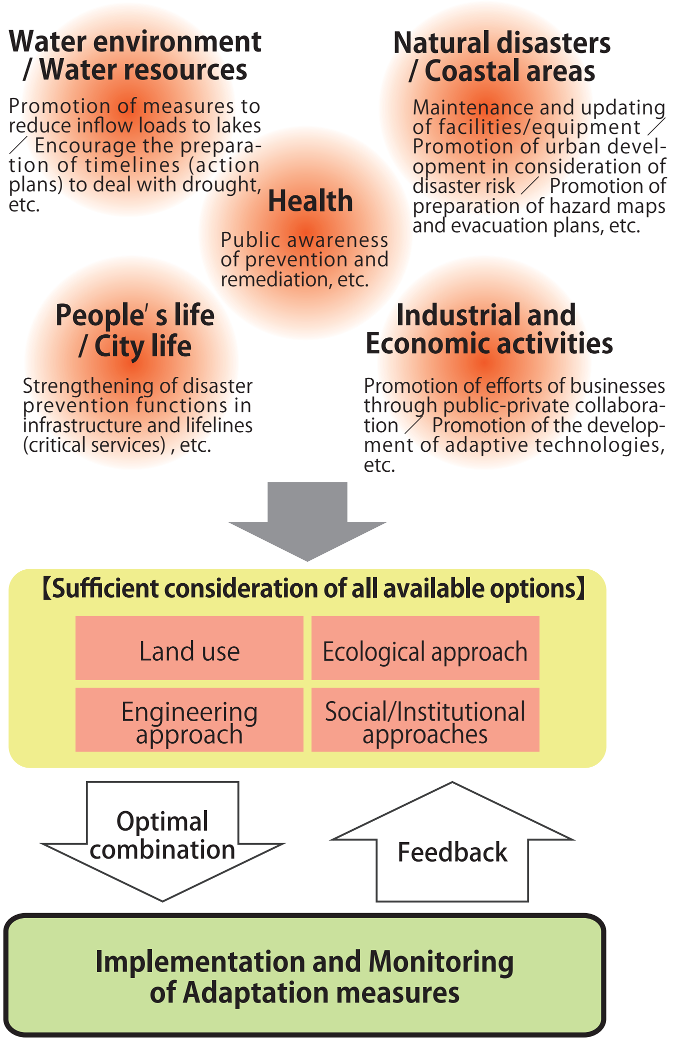
- **The potential of ecosystem-based adaptation options as contrasted with technological solutions should be fully considered.**
- **Strategic environmental assessment and environmental impact assessment should be applied in a way that ensures full consideration of all available alternatives.**
- **The value of biodiversity and ecosystem services should be considered in decision making processes.**
- **Adaptation decisions should allow for monitoring and adaptive management approaches.**

There are various approaches to adaptation measures, which include land use, ecological, engineering, and social/institutional approaches. Adaptation activities should be implemented in a comprehensive manner to prevent or minimize adverse impacts on biodiversity in addition to the consideration of effects, easiness, costs and durability.

The ecosystem-based adaptation measures and those combining artificial structures and restoration of nature can also contribute to the conservation of biodiversity. When implementing an adaptation measure, it is desirable to choose methods that contribute to or maximize the effect of conservation of biodiversity.

Even when the engineering techniques are considered as adaptation measures, it is desired to check the impaired value of biodiversity and ecosystem services by the affected natural environment.

Careful checking is necessary, especially for national parks, wildlife sanctuaries and other areas important for biodiversity conservation.



Activities on Ecosystem

■ Examples of inappropriate adaptation measures that have been shown in the IPCC-AR5 (Excerpt)

- Engineered defenses that preclude alternative approaches such EBA
- Adaptation actions not taking wider impacts into account.
- Forgoing longer term benefits in favour of immediate adaptive actions.
- Depletion of natural capital leading to greater vulnerability.
- Adopting actions that ignore local relationships, traditions, traditional knowledge or property rights, leading to eventual failure
- Adopting actions that favour directly or indirectly one group over others leading to breakdown and possibly conflict.
- Retaining traditional responses that are no longer appropriate

Source：I.R., S. Huq, Y.A. Anokhin, J. Carmin, D. Goudou, F.P. Lansigan, B. Osman-Elasha, and A. Villamizar（2014）
Adaptation needs and options. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. p858（Excerpt from Table14-4 ）

New Orleans: Preserving Wetlands to Increase Climate Resilience

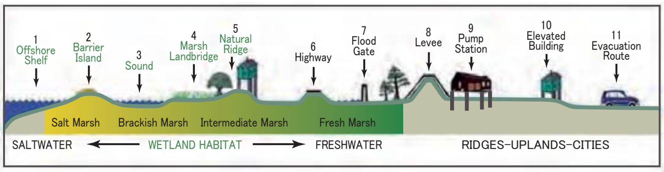
New Orleans is a major port in the United States, and the largest city and metropolitan area in the state of Louisiana. It is located in the southeastern part of the state, on the Gulf of Mexico, which is characterized by frequent hurricanes. According to the Federal Emergency Management Agency, New Orleans is the most vulnerable American city to hurricanes. The high risk is due to the city' s low elevation, as most of it is currently between 0.6 to 5m below sea level, and the city is surrounded by water on the north, west and south.

Louisiana' s coastal zone was formed by sediments deposited during a series of major Mississippi River deltaic episodes, which have created a region of coastal wetlands covering over 13,000 square kilometers, and these wetlands represent 30% of the total coastal wetlands in the United States. However, it is estimated that Louisiana has lost more than 3,000 square miles of its coast in the last 70 to 80 years alone, equivalent to a rate of nearly 62 square kilometers per year. This loss is caused by coastal erosion due to levees built along the Mississippi River. Construction of artificial channels for oil and gas drilling and other commercial activities has also destroyed wetland areas, and hurricanes also damage wetlands.

However, wetlands play an important role in mitigating the severity of hurricanes. They do this by decreasing the area of open water for wind to form waves, increasing the drag on water motion, and hence reducing the amplitude of storm surges, reducing direct wind effects on the water surface, and directly absorbing wave energy. Indeed, around metropolitan New Orleans, where wetlands have historically formed a critical storm surge buffer, the loss of coastal marshes as a result of Hurricane Katrina in 2005 was so great that it represented about 50 years of projected wetland loss.

A major lesson from Hurricane Katrina is that New Orleans cannot simply rely on bigger or better levees, gates, and pumps for flood protection.
Following the disastrous failure of structural flood defenses during Hurricane Katrina, the State of Louisiana and City of New Orleans have undertaken steps to increase the resilience of the city to sea-level rise, hurricanes and river flooding. An approach utilising many lines of defense has been adopted, involving structural and non-structural defenses. One of the key protection measures is the conservation and restoration of wetlands as a buffer zone between the sea and the city.

Current plans are to restore as much of the wetlands as quickly as possible. This will involve a combination of restoration of natural delta building, marsh creation from use of dredged material, water control structures, and hard structures (e.g., levees and floodgates). The interior marshes have been prioritized for conservation and restoration because of the ecosystem services they provide, combined with the storm surge protection they offer to densely populated areas including New Orleans. The city must adopt a strategy that addresses multiple lines of defense (see figure), some of which will require continued advocacy and vigilance, and some of which the city and its citizens can take charge of themselves.



The multiple lines of defense range from restoration of coastal wetlands, development of hard infrastructure, and nonstructural strategies such as land use and building codes, and enhanced emergency preparedness.

Source：Kazmierczak, A. and Carter, J. (2010) New Orleans: Preserving the wetlands to increase climate change resilience, Adaptation to climate change using green and blue infrastructure. A database of case studies; http://grabs-eu.org/membersArea/files/new_orleans.pdf

Case study that can be the consideration of the other adaptation measures

- Maintenance and creation of new habitats of wild animals and plants in combination with the management of retarding basins.
- “Reef construction (“Chiku-Iso” by restoring past rocky shore at the maintenance of breakwater.
- Retract and set back the seawall location in the land, to leave the sandbar or wetlands to the seawall front at the installation of seawall for storm surge.

Watarase Yusuichi

Source：Oyama city

Promotion of Ecosystem-based Adaptation

The ecosystem has many functions, and the benefits supplied to human is referred to as the "ecosystem services". The ecosystem services include various category, such as the supply of such as food and wood, regulation of temperature, purification of water, protection of the natural disaster, cultural and spiritual quality improvement. As part of an overall adaptation strategy to climate change, the strategy that take advantage of the biodiversity and ecosystem services is called as "adaptation measures that take advantage of the ecosystem (Ecosystem based Adaptation (EbA for short))".

Ecosystem-based adaptation measures include forest growing to prevent sediment disasters, conservation of coral reefs and development of seaside protection forests to reduce damage by typhoons and high tides, and mitigation of heat through tree transpiration and shades. We can use these ecosystem functions to reduce danger by conserving—not developing—areas with high disaster risk, or by returning such areas that also face population decline to their natural conditions.

In addition, it is necessary to take into account that ecosystem conservation or restoration can contribute to mitigation because some ecosystems may absorb greenhouse gas. Adequate utilization of an ecosystem can generate both mitigation and adaptation effects.

Ecosystem-based adaptation can be a useful and widely applicable approach to adaptation. Proper design, execution and monitoring are necessary in order to obtain a sufficient effect.

- Can be applied at regional, national and local levels, and at both project and programmatic levels, and benefits can be realized over short and long time scales.
- May be more cost-effective and more accessible to rural or poor communities than measures based on hard infrastructure and engineering.
- Can integrate and maintain traditional and local knowledge and cultural values.
- Generate multiple social, economic and cultural co-benefits for local communities.
- Contribute to the conservation and sustainable use of biodiversity.
- Contribute to climate change mitigation and generate synergy, by conserving carbon stocks, reducing emissions caused by ecosystem degradation and loss, or enhancing carbon stocks.

Ecosystem-based adaptation is getting increased attention also internationally. The first United Nations Environment Assembly in 2014 adopted a resolution on Ecosystem-based Adaptation encouraging all countries to include and improve ecosystem-based adaptation in their national policies, including those on climate change adaptation.

Ecosystem-based adaptation is effective both on economic and social fronts and extremely important if Japan is to accomplish adaptation and national resilience with a declining population.

By positioning ecosystem-based adaptation in community development, we can also widen the scope of choices of adaptation measures.

At this time, a concept, as well as concrete and technical guidelines for utilization, is not sufficient. It is necessary, while carrying out research studies, to collect existing knowledge, cases, functional assessment techniques, etc. concerning ecosystem-based adaptation measures, decide the direction of efforts, perspectives, space planning and utilization in the field, and start to work from projects that promise effects in an adaptive manner.

Mangrove forest

Ecosystem-based adaptation（Verde island passage,Philippines）

As climate change intensifies, its negative effects are becoming more pronounced, especially in coastal communities where people directly depend on marine resources for livelihoods and marine-based goods and services.

In response, Conservation International (CI) is implementing projects to help people adapt through Ecosystem-based Adaptation (EbA).

In the Philippines, CI project activities focused on demonstrating the use of ecosystems to help people adapt to climate change in coastal communities in the Verde Island Passage. Activities were centered on the active rehabilitation and management of mangrove and beach forest ecosystems, and on the implementation of fisheries management strategies to assist fish stock replenishment.

CI-Philippines conducted a vulnerability assessment in the Verde Island Passage (VIP), finding that the highest priority actions are: to address coastal flooding and erosion from changing storm patterns and sea-level rise; to improve the resilience of local livelihoods through diversification of income sources away from primarily fishing; and to build the resilience of local fisheries to coral bleaching, erosion and degradation of coastal habitats.

CI-Philippines' cost-effectiveness study showed that EbA mangrove rehabilitation is a cost-effective option compared with traditional engineering options.

c Burt Jones and Maurine Shimlock

■Project Outcomes in Philippines

In the Verde Island Passage, CI-Philippines completed two EbA pilot projects to increase climate resilience by:

- Restoring and protecting mangroves to secure the coastline and increase coastal resilience to storm surges, flooding and erosion
- Improving fishing practices, and designing and implementing climate-smart marine protected areas

【Successful Capacity-building】

More than 60 community members are actively engaged in mangrove rehabilitation, management and protection—40 of whom have been deputized to conduct mangrove enforcement work by the Local Government Units.

【Mangrove Rehabilitation and Protection】

Rehabilitated 100 hectares, and protected & managed 400 hectares, of mangrove forest in Barangay Silonay, Calapan City in Oriental Mindoro, Barangay Balibago, and Calatagan in Batangas. These coastal communities now have a more robust natural buffer against strong wind, storm surges and coastal degradation.

【Income Diversification of Residents】

Established and sustained 12 income diversification activities in 4 pilot communities in the Verde Island Passage, where 60 people were formally trained on various income diversification activities, ranging from ecotourism to management to of a convenience store

【Fisheries & Livelihood Policy Outcomes】

Successfully implemented the first Local Government Unit-initiated seasonal closure in Balayan Bay and the first with a climate change objective; livelihood options have been provided by the Department of Social Welfare and Development to affected fishers under the Cash-for-Building Livelihood Assets scheme

Souce：Conservation International "ECOSYSTEM-BASED ADAPTATION IN THE PHILIPPINES"
http://www.conservation.org/publications/Documents/CI_EbA-Philippines-Factsheet.pdf

Case study that can be the ecosystem-based adaptation s

- Log coniferous and plant broadleaf trees in the logged areas, in order to convert to mixed forests of coniferous and broadleaf trees. (Mixed forests have higher water and soil conservation functions and are more tolerant to wind damage.)　(Corresponding to the expected increase of landslide disasters under the severe rainfall)
- Plant trees together in urban areas (e.g., trees lining streets), as a measure to contribute to climate change mitigation, and also as a measure to mitigate the heat-island effect. (Corresponding to the expected impact on life by the summer heat)
- Conserve and restore tidal flats (which have water purification functions), in order to contribute to water quality purification in coastal areas. (Corresponding to the expected water quality deterioration in the coastal areas or closed-waters)

Yatsu-higata

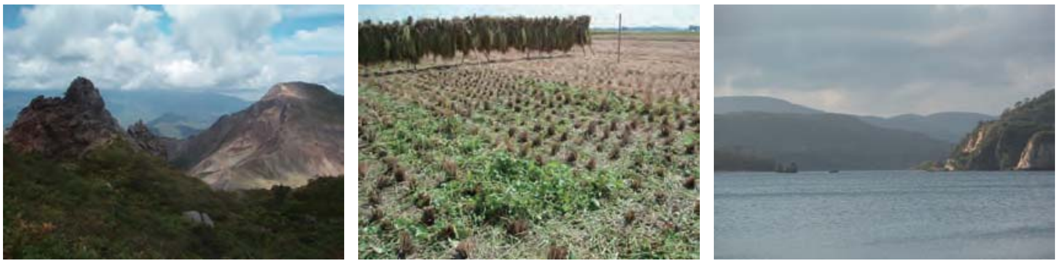
Promotion of Efforts in Each Region

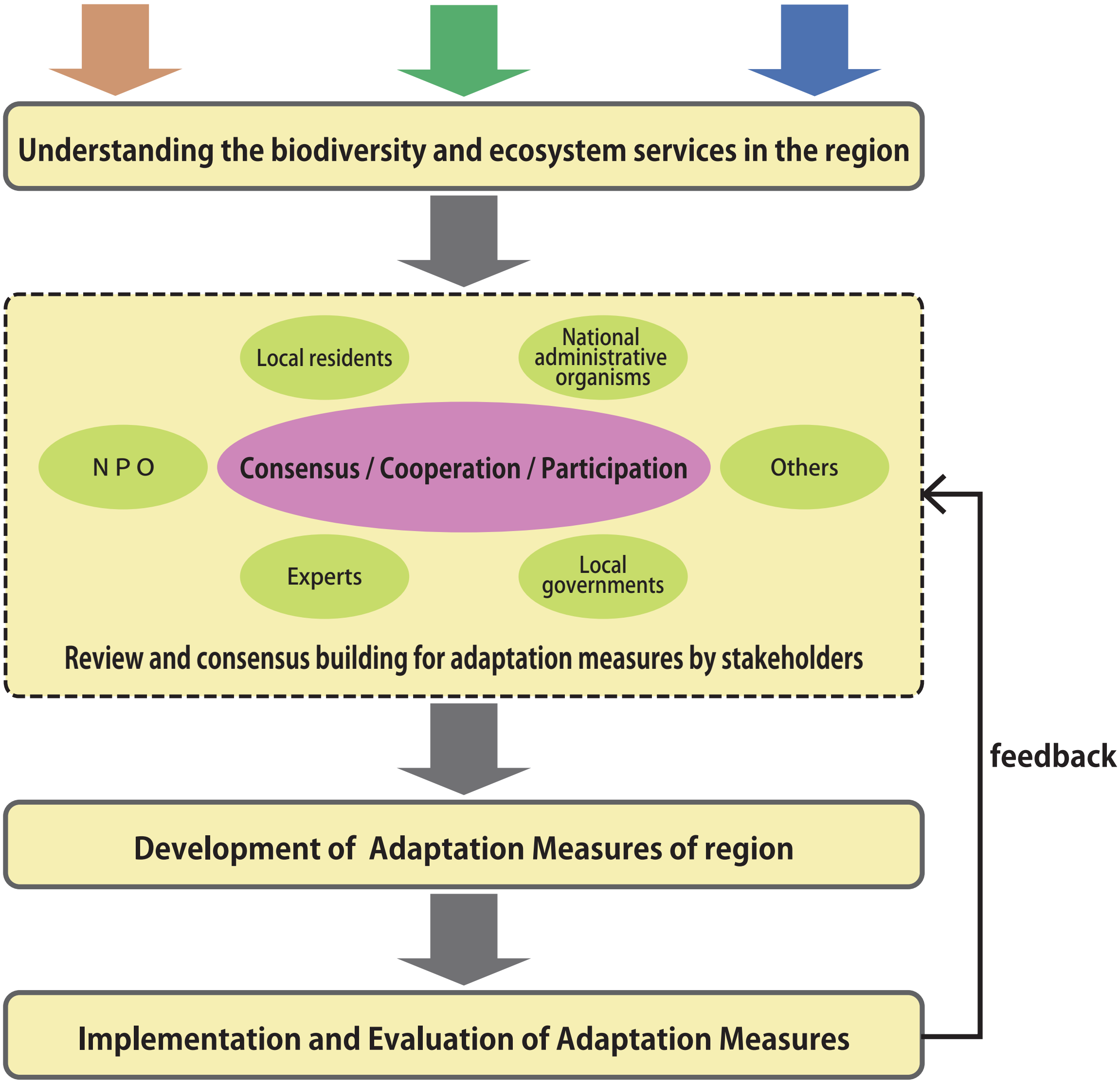
The impact of ecosystem change caused by climate change varies depending on the value of the biodiversity and use and enjoyment of ecosystem services in the region, which makes it essential to make efforts based on these characteristics. For this purpose, it is desirable to assess the impact on the biodiversity and ecosystem services in the region and discuss the implementation of adaptation activities in line with the wishes of the stakeholders in the region.

It is also desirable to make wide-area efforts at flood plain level, etc. beyond administrative units. In this regard, it is effective for multiple municipalities in a flood plain, etc. to formulate regional biodiversity strategies incorporating the impacts of climate change and adaptation activities.

■ Image of efforts in each region ■

There is a different natural environment, wisdom and technology of life in each region.
It is necessary to consider the adaptation measures of region based on them.





Community-Based Adaptation Project : Bangladesh

It is increasingly recognized that small communities are likely to be the most severely affected by climate change impacts and yet are least equipped to cope and adapt. This pilot project is designed to implement community-based projects that seek to enhance the resiliency of communities, and/or the ecosystems on which they rely, to climate change impacts. It will essentially create small-scale/policy laboratories and generate knowledge about how to achieve adaptation at the local level.Ten participating countries (Bangladesh, Bolivia, Guatemala, Jamaica, Kazakhstan, Morocco, Namibia, Niger, Samoa, and Vietnam) each developed, planned and implemented a portfolio of community-level adaptation projects. The UNDP-ALM pages linked below feature information on each of these projects, including a detailed description, expected results and outputs, funding, and associated documents.

1） Community-Based Wetland Project

The indigenous Chakma peoples (pop. ~2,000) in the five villages of Borkona Godabanne Chora Adam face declining rainfall, rising temperatures, and decreased water levels under climate change. The nearby Godabanne Chora stream is the main source of irrigation and fish farming in the area, but climate change forecasts predict that current climate shifts will continue towards warmer and drier conditions—with negative consequences to both ecosystems and livelihoods.

This project will increase the community' s capacity to adapt to adverse climate conditions and sustainably manage the wetland area. It focuses on promoting sustainable crop varieties, improved agricultural practices, and improved water collection. The project will also train community members in alternative income-generating activities to reduce pressure on natural resources and diversify income sources. Conservation of biodiversity is a strong component of this project and a community committee will be established to protect and care for the ecosystem.

2） Coping with Climate Risks by Empowering Women in Coastal Areas

This project aims to reduce the vulnerability of people living in four proposed villages under Dashmina upazila in Bangladesh by establishing Women Resource Centers (WRC) that will foster a community approach to climate change awareness and adaptation planning. The target sites already face an eroding natural resource base and biodiversity, and the potential for damaging cyclones, tidal surges, and drought are projected to increase.

By empowering marginalized women, this project will increase their access to resources, diversified livelihood activities, health and sanitation needs, and agricultural production. Teams of 18-20 women will be responsible for establishing and operating seed banks, planting nurseries, building vegetable gardens, rearing livestock, and coordinating climate change awareness campaigns. Gram Bikash Shohayak Shangstha (GBSS), the coordinating NGO, will ensure that the women have appropriate access to materials and funds by establishing linkages with government, NGO, and community leaders.

3） Piloting Climate-Resilient Development Initiatives

Char Kazul is a riverine island comprised of four villages, located between the Bura Gaurango and Tetulia rivers in Bangladesh. During monsoon season, the Bura Gaurango River can swell up to 10km wide, making it difficult for residents to reach the mainland for trade and services. Climate change models predict more frequent cyclones over a longer season, which will increase the occurrence of storm surges, riverbank erosion, salinity intrusion, abnormal high tides, rough sea weather conditions, and erratic rainfall. Changing weather patterns and social pressures have resulted in widespread degradation of arable land, as well as negative impacts on local flora and fauna.

This project (July 2011-December 2012) improves community-based adaptive capacity by piloting sustainable agriculture practices and promoting land conservation. Demonstration and promotion of saline-tolerant rice varieties, alternative crops, and crop intensification will improve agriculture production whilst reducing the effect of climate related risks. Additionally, the project will increase the capacity for coping with natural weather hazards by rehabilitating mangrove forests and renovating house and boat structures.

4） Strengthening Community Resilience in the Southwestern Coastal Area

Due to its high levels of poverty and close proximity to water, Atulia Union in the southwestern coastal region of Bangladesh is considered to be one of the most vulnerable areas to climate change. Over the last few decades both farming and aquaculture activities have become less productive as soil degrades, water salinizes, and competition for resources increases. More than 56 percent of the area' s population is now food-deficient for 2 to 6 months out of every year. After being severely damaged by the 2009 Aila cyclone, local soil and water ecosystems became weakened and are thus more vulnerable to subsequent climatic impacts. Area villages also suffered from infrastructure damage, loss of property, and loss of livelihood during the cyclone.

This project aims to improve the resilience of Bangladesh' s coastal communities through strengthened ecosystem functions and protected livelihoods. The community will benefit from improved aquaculture practices and reduced negative pressure on natural aquatic animals, thereby enhancing livelihood opportunities. A thriving model of sustainable development will improve the resilience of the community—and the local ecosystem—to climate change impacts.

5） Promoting Diversified Agro-Based Activities in Jamalpur District

In the hilly areas of Bakshigani Upazila region, the Adibashi community faces increased heavy rainfall and more frequent droughts. The region' s traditional hillside farming technique, known as jhum cultivation, gradually deteriorates the hillside environment, thereby increasing the risks of flash floods and landslides. Projected climatic changes exacerbate this risk, reducing the amount of cultivable land and threatening livelihoods.

This Community-Based Adaptation project works to reduce land degradation and increase the adaptive capacity of seven vulnerable hill villages where the natural resource base is quickly depleting. Homestead-based mixed vegetable cultivation, fruit cultivation, fish production, and terracing techniques will be promoted as alternatives to jhum methods as a way to reverse land degradation and diversify income. Awareness activities will further enhance the community' s understanding of climate change, better equipping them to adapt to its impacts.

Source：UNDP（2015）Community-Based Adaptation: Bangladesh,
http://www.adaptation-undp.org/projects/spa-community-based-adaptation-bangladesh

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