



Sustainable Earth

Disaster prevention investment that is directly linked to economic growth

Building resilient cities across the world



In recent years, large-scale natural disasters have been occurring one after another in various parts of the world. Natural disasters, such as floods, droughts, intense heat, or cold waves are increasing in frequency due to the impacts of climate change. Such disasters not only have a severe detrimental impact on ecological systems, but also adversely affect human life and health, as well as economic and social activities. In particular, economic losses due to disasters in recent years have risen dramatically, and are becoming a major issue whether it is in growing cities or developed countries. To respond to the threat of frequently-occurring natural disasters, a diverse range of both hard and soft measures, including physical, institutional, and social methods, are required. Furthermore, the fields in which ICT is expected to provide solutions to these issues extend over a diverse range, including optimal utilization of resources and crisis response to disasters among other things. NEC aims to create resilient cities that can respond quickly and flexibly to natural disasters and keep damage to a minimum by utilizing the latest ICT, such as global sensing, IoT (Internet of Things), AI (Artificial Intelligence), and simulation technology. This report overviews the latest trends in disaster prevention measures around the world, as well as initiatives and cutting-edge technologies that NEC has developed both in Japan and overseas with the aim of co-existence with earth.



"Mitigation measures" and "adaptation measures" that are needed to tackle global warming

In recent years, the progression of global warming has become a major issue around the world, and action is being taken on a global scale under the auspices of the United Nations Intergovernmental Panel on Climate Change (IPCC) and Conference of the Parties (COP). According to the Fifth Assessment Report on the latest scientific knowledge concerning global warming compiled by the IPCC, global average temperature has risen 0.85°C between 1880 and 2012. The report predicts that if emissions of greenhouse gases continue at current levels, average temperature could increase by a maximum of 4.8°C by the end of this century, as compared to the end of the 20th century.

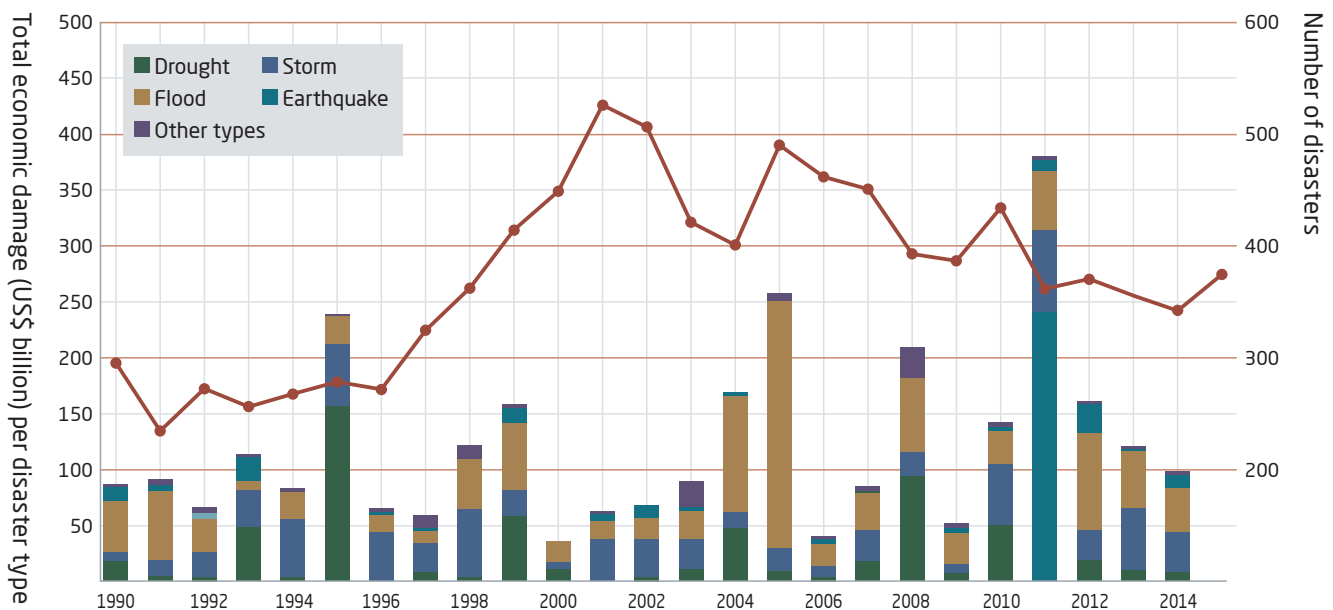
Furthermore, due to climate change such as global warming, the frequency of natural disasters has increased dramatically in the last 30 years. According to the EM-DAT database of the Centre for Research on the Epidemiology of Disasters at the Université Catholique de Louvain in Belgium, which has compiled data on more than 12,000 disasters from 1900 to present, the number of natural disasters worldwide have approximately doubled in the 20-year period from the 1980's to the 2000's. As a result, the economic losses due to natural disasters have also increased dramatically. Global economic losses remained at levels below \$100 billion annually up to the early 1990's, but in recent years, it is not unusual for economic losses to exceed \$200 billion.

In the face of climate change and ensuing natural disasters, what kind of action can we take? Measures on the

problems of climate change can be divided into two major types: "mitigation measures" and "adaptation measures." As the name suggests, "mitigation measures" seek to reduce the impacts of climate change due to warming. A specific example would be initiatives to reduce emissions of greenhouse gases such as CO₂. To reduce the impacts of climate change, the IPCC has pointed out that it would be necessary to hold the average temperature increase to under 2°C compared to the start of the Industrial Revolution in the second half of the 18th century. For this purpose, greenhouse gas emissions must be cut by 40 to 70% by 2050 compared to 2010, and emissions reduced to zero by the end of this century. In addition, it is also necessary to achieve negative emissions by recovering CO₂ from greenhouse gases that have been emitted and storing it deep in the earth. But it will take time to achieve these goals.

This is where the importance of "adaptation measures" comes into play. It is difficult to avoid the impacts of greenhouse gases that have already been emitted and accumulated in the atmosphere, and natural disasters are showing a tendency to occur more frequently and with greater intensity. To prepare for natural disasters due to climate change that are expected to cause extensive damage, we have to make adjustments in the state of human society. For this purpose, we need to work on "adaptation measures" while continuing to implement "mitigation measures" simultaneously.

Number of reported natural disasters in the world and economic damage



* Based on EM-DAT (The International Disaster Database) data. The bar graph represents the total amount of damage and the line graph represents the number of disasters.



Efforts that address climate change at the world level

In the Global Risks Report 2016 released by the World Economic Forum (WEF) in January this year, it was pointed out that the global risk that will have the biggest potential impact this year is the “failure of climate-change mitigation and adaptation.” Furthermore, action on climate change was set as one of the 17 Sustainable Development Goals (SDGs) which were adopted by the United Nations in September 2015. Measures at the country level are being taken in various parts of the world in order to deal with severe climate change on a global scale.

It goes without saying that the importance of climate change measures is a topic that has been debated for many years. The debate started in the first half of the 1990's, and has now arrived at the stage of taking concrete action. However, looking at the current state of climate change measures around the world, it can be seen that there is a wide variation depending on the economic strength of a country.

In a survey conducted during 2014-2015 by a team of researchers from the University College London led by geographer Lucien Georgeson, it was reported that cities in developed countries are spending more on climate change measures both in terms of total amount and as a percentage of GDP than those in developing countries. If spending is low on measures, such as improvement of drainage systems, shore protection, and strengthening of

infrastructure recovery, disaster damage is more likely to worsen.

In view of this kind of situation, the “Cancun Agreements” were proposed at the Fifteenth Session of the Conference of Parties to the United Nations Framework Convention on Climate Change (COP15) held in Copenhagen in 2009, and officially adopted at COP16 in the following year. It was set forth in the agreements that “developed countries will mobilize \$100 billion from both private and public sources to meet the financing needs of developing countries to address climate change by 2020.” The Green Climate Fund was established to achieve this international agreement, and as of May 2015, the fund has started operating with the US making a pledge of \$3 billion, Japan \$1.5 billion, England \$1.2 billion, France and Germany \$1 billion each.

According to GCF Insight 2016 published by the fund, out of the funds that have been raised, 50% will be used for mitigation measures to reduce greenhouse gas emissions in growing cities, and the remaining funds on adaptation measures in growing cities that are plagued by abnormal weather patterns and island countries facing the threat of flooding. Looking at the global trends, spending on measures to address climate change will make up an increasingly bigger proportion of the world economy.

SUSTAINABLE DEVELOPMENT GOALS 17 GOALS TO TRANSFORM OUR WORLD



* UN SDGs (Sustainable Development Goals) <http://www.un.org/sdgs/>



“Mainstreaming disaster risk reduction” and investment in disaster risk reduction which are indispensable for economic growth

As natural disasters worldwide increase in frequency and intensity, there is a trend in the rise of economic damage. As mentioned in the previous section, looking at the scale of disasters that had shaken the foundations of the regions and countries in which they had struck in the last 10 years, there is an overall tendency for the economic damage to keep escalating. Furthermore, in growing cities that do not have sufficient resources for disaster prevention, sustainable development is disrupted by disasters, causing economic growth to stagnate.

In view of this kind of trend, the emphasis is currently placed on “mainstreaming disaster risk reduction (DRR)” around the world. To reduce the damage from disasters, it is necessary to take proactive action and implement comprehensive measures in advance in addition to

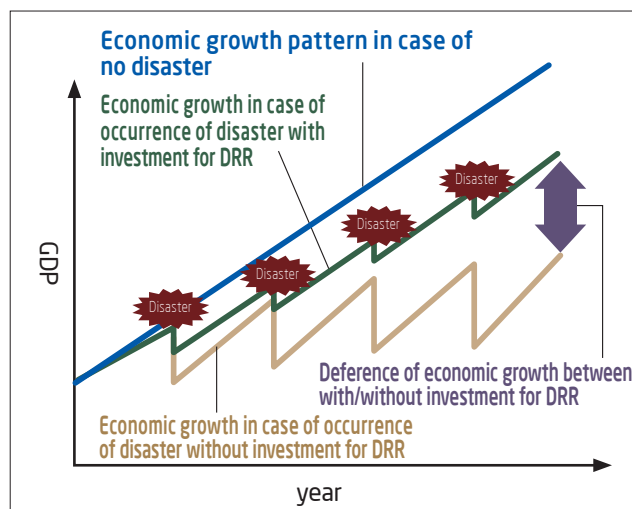
post-disaster measures that address specific emergency needs. This stance is important for the purpose of achieving sustainable development in society and the economy, and sharing this basic perception lies at the root of “mainstreaming DRR.” The basic approach is set forth in the three points below.

1. Governments shall prioritize DRR in their country’s policy.
2. Disaster risk reduction is incorporated into plans and programs for development in all sectors or fields.
3. Increasing prior investment in DRR.

To give an example, during Hurricane Katrina, which hit New Orleans, Louisiana in the US in late August 2005, the total amount of damage exceeded 14 trillion yen. If 220 billion yen had been invested in bank reinforcement in advance, the damage due to the hurricane could have been reduced to zero according to government estimates *. This is just one example from a developed country, but it can be said that the economic effect from investment in disaster prevention is extremely important also in growing cities that are continuing to develop.

Viewed in this way, we can understand why various counties are starting to make efforts on “mainstreaming DRR.” To achieve progress in such efforts, not only do all sectors, such as the central government, local governments and communities, have to work together to carry out infrastructure upgrading and monitoring, it is also necessary to make efforts beginning with educating and training people in local governments, and establishing organizations and systems at the country level. In efforts that require making approaches from both the soft and hard aspects, the scope in which ICT can make a contribution will keep expanding.

Pattern diagram of investment for DRR and economic development



* Based on “Towards Mainstreaming Disaster Risk Reduction” published by Japan International Cooperation Agency (JICA) (March 2015)

Efforts towards mainstreaming DRR that straddle different sectors



* Source Japan International Cooperation Agency (JICA)

* Ministry of Land, Infrastructure, Transport and Tourism: From Overview of River Projects 2007 “Current Status and Issues of Rivers” http://www.mlit.go.jp/river/pamphlet_jirei/kasen/gaiyou/panf/gaiyou2007/



Global sensing that is indispensable to disaster response measures

To implement mitigation and adaptation measures for climate change, it is necessary to monitor and analyze changes in global environment that straddle country borders. One of the methods which play an extremely important role is satellites that can gather wide-area observation data on earth simultaneously. Currently, sensing using satellites is one of the fields in which technological development is most active. Using sensors mounted on satellites, it is possible to observe a wide range of information, such as temperatures on earth and atmospheric composition, sea surface temperature and rainfall, water cycle, snowfall, thickness of ice, state of vegetation, and detection of forest fires.

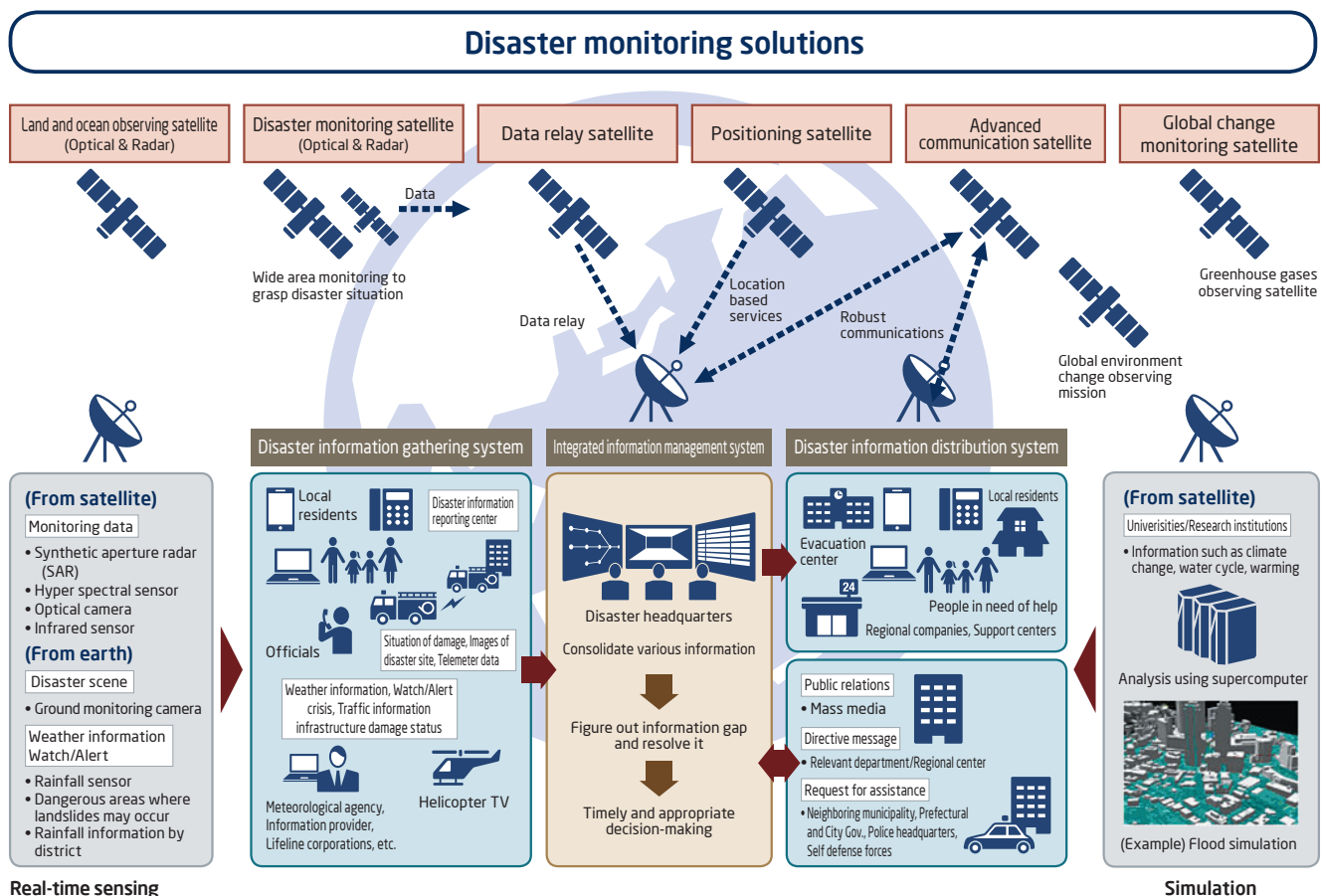
In addition, multi-faceted data can be collected by combining sensing through satellites with sensors installed on the ground and in the sea. The environment data gathered using satellites and ground systems in this way are integrated and analyzed in supercomputers, and methods have already been established to utilize the results to predict disasters and understand the conditions.

NEC has a proven track record in diverse domains in relation to solutions that utilize different types of sensors installed in different locations from satellites to

the sea bed. In particular, NEC offers a range of solutions using global sensing based on the themes of "disaster monitoring" and "environment monitoring."

For example, in the area of disaster monitoring, NEC aims to create and provide fast and appropriate disaster response measures by identifying wide-area disaster conditions using satellites, and collecting/analyzing/assessing various information via data transmission in space or between space and earth. In the area of environment monitoring, NEC is helping to investigate the mechanisms of environment change and improve the accuracy of climate modeling by making use of the ground observation data described above in order to improve and protect earth's environment.

NEC has extensive experience in building information systems and telecommunications systems in companies, research institutions, universities, local governments, central ministries, and agencies. Furthermore, NEC also has a wealth of technologies and operating experience in the field of information terminals, such as mobile phones and various types of display. NEC is integrating all the technologies and experience at its disposal to create and provide integrated disaster prevention solutions.





Disaster prevention that changes with the use of simulation systems

To minimize economic loss from natural disasters brought about by climate change, it has proven to be extremely effective to use simulation technology to predict the risks and the scope/timing/degree of damage, and to adopt appropriate measures in advance.

It is also possible to make faster and more detailed predictions of weather phenomena by using environment data collected from various sensors.

Through simulations based on this kind of weather predictions, forecasts of risks and the expected damage can be provided with more accuracy, speed, and detail, thus making it possible to propose disaster prevention measures that have greater adaptability to actual conditions.

NEC has been developing simulation systems targeted at various natural disasters such as floods and landslides, and putting them into practical use. An example is a flood simulation system on which trials have been conducted in Thailand. During the period from November 2015 to March 2016, NEC conducted trials of its flood simulation system in collaboration with Thailand's National Disaster Warning Center (NDWC), and confirmed the effectiveness of the system.

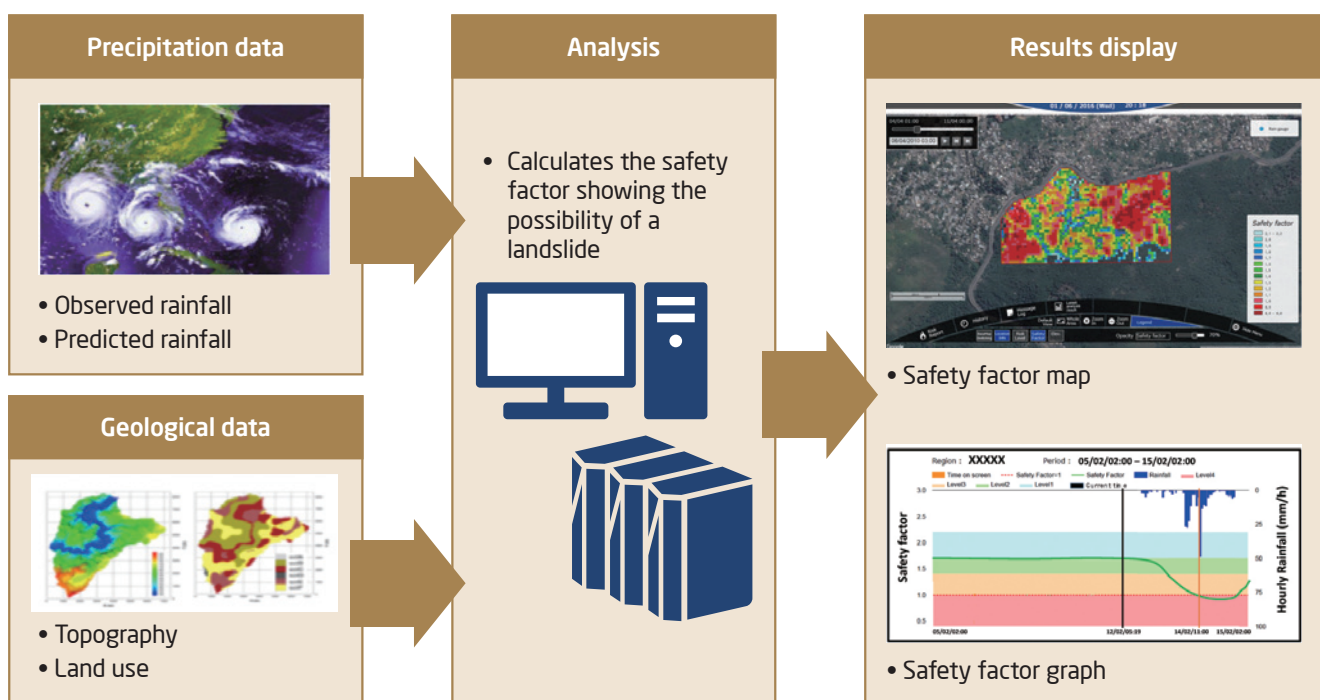
NEC also successfully concluded a series of trials using its innovative tool for landslide simulation to analyze the

stability of slopes in Rio de Janeiro, Brazil from April to May, 2015. Rio de Janeiro was struck by big-scale landslides due to torrential rains in January 2011, and the city's residents have a high level of interest in measures that protect them from the threat of landslides.

In the trials using NEC's landslide simulation system, a wide range of real time weather data including soil conditions on slopes and rain data are combined and analyzed to determine the stability of slopes. This makes it possible to provide highly accurate landslide risk levels in high risk areas, which can be expected to give further support for effective decision-making in disaster prevention, such as issuing early evacuation warnings to the residents. Based on the results of the trials, NEC will continue to develop this system for monitoring landslide conditions and strengthen its technologies further.

It is important to establish disaster prevention measures in advance based on highly accurate forecasts/predictions in order to respond to big-scale natural disasters. Using the simulation technologies described above, NEC aims to create and provide disaster prevention measures with greater adaptability to minimize the scale of damage.

Structure of the landslide simulation system





Disaster monitoring of the future that will be changed by IoT and AI

NEC is making advances in research and development of sensing, IoT, AI, and control technology as the core technologies of its businesses in future. By combining these technologies, NEC aims to create and provide solutions that are useful in disaster prevention.

In the sensing and IoT domains, NEC has pioneered a new technology for high-precision, real-time calculation of the risk of a mudslide on a slope by analyzing multiple data-indices obtained from the soil moisture content and vibration sensors. This technology enables a slope's risk level to be calculated using approximately 1/3 the number of sensors required conventionally, making it possible to install sensors over a wider area at a similar cost to conventional methods. This highly accurate identification of slopes that are at high risk of a landslide helps provide sufficient time for the evacuation and safety of local residents by contributing to the speedy issuance of evacuation advisories and/or evacuation orders. Trials on this technology have already been conducted in Shimane prefecture, Japan in June 2015.

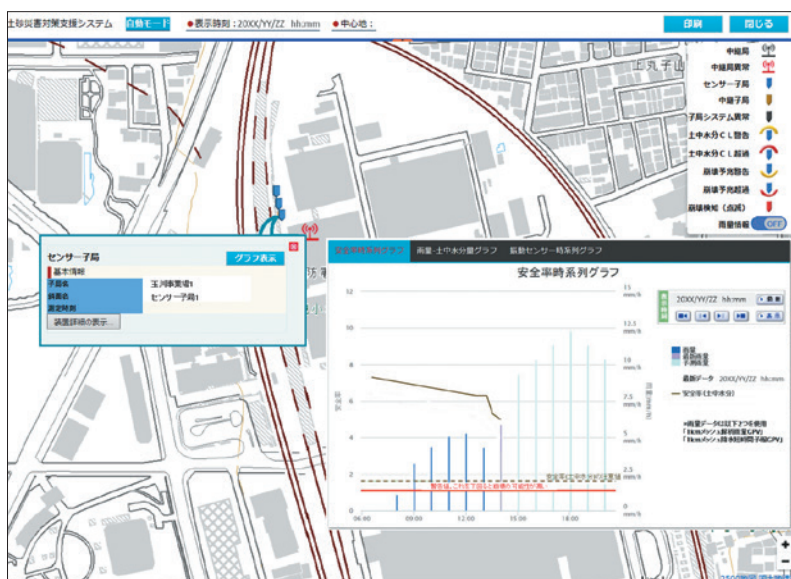
In AI technology, NEC established the NEC-AIST AI Research Laboratory in collaboration with The National Institute of Advanced Industrial Science and Technology (AIST) on June 1, 2016. The laboratory aims to detect abnormal phenomena that cannot be discovered using conventional means by combining NEC's advanced AI technologies that lead to solutions from huge data with AIST's simulation technologies. For example, an area

that is attracting attention is the possibility of detecting/predicting unexpected rare disasters, such as "conditions for the occurrence of super-typhoons."

When a disaster strikes, it is necessary to have in place a system that allows for a flexible response to be made according to changes in the environment. NEC is conducting research on an autonomous and adaptive control technology for optimizing allocation of resources in response to environmental changes that are difficult to predict in advance in order to contribute to the creation of advanced social infrastructure based on IoT. NEC aims to build more resilient social infrastructure in response to environmental changes that may occur due to abnormal weather/disasters/incidents/accidents by using methods of controlling IoT systems based on indices such as safety, efficiency and comfort.

While respecting the essential values pursued by society and by their customers, NEC wishes to work together with everyone and use the ICT to design new social values for the sake of a brighter world. If you have any questions concerning the contents of this report or NEC initiatives, please do not hesitate to contact us.

NEC's data analysis technology that monitors the stability of slopes in real time



Source: Press release - "NEC releases a 'Landslide Prediction Solution' that visualizes the risk of a mudslide on a slope by analyzing the soil moisture content"





NEC Group is focusing its efforts on providing "Solutions for Society" by upgrading the social infrastructure with ICT. NEC defined six megatrends based on a structural observation of the global economy and social trends. Based on the six megatrends, NEC formulated seven themes for social value creation as its mission.



Sustainable Earth

Establish a sustainable lifestyle base by utilizing limited resources effectively and taking measures to prevent damage to the global environment in order to live in harmony with the Earth.



Safer Cities & Public Services

Help emerging countries build safe and secure cities, and help developed countries mature their societies. Establish a "global" administrative service platform through joint initiatives between the public and private sectors.



Lifeline Infrastructure

Establish ICT systems that resolve disparities of area and delivery time, and build safe and efficient lines for travel, utilities, etc. that can support around-the-clock activities in society.



Communication

Build a platform for information and communications to support the distribution of information and knowledge, which becomes more important as society advances.



Industry Eco-System

Innovate a new industrial ecosystem including connection of industrial machinery with the Internet, 3D printers, crowdsourcing and reverse innovation.



Work Style

Create new work style and relationship with society in which people work together with communities and robots regardless of gender and generation.



Quality of Life

Build a diversified and equal society to support people's enriched and active lives through contributions to education, healthcare and medicine.

This Social Value Creation Report is issued for each of the seven themes listed above and summarizes NEC's concepts, efforts, and proposals, in addition to social issues and global trends. NEC hopes that this report can be the first step in establishing cooperative creative partnerships with customers.

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