The need to reinforce soil science research and the information basis to respond to both gradual and sudden changes in our environment

28 January 2016
Soil Science Subcommittee, Agronomy Committee, Science Council of Japan

1. Background

Soil is one of the most important components of Earth's surface in terms of its contribution to the biological environment, the atmosphere, and bodies of water. Thus, soil's continuing functioning is essential in agriculture and forestry for crop and wood production (i.e., its *production* function) that supply food, clothing, shelter, and, to some extent, energy. The production aspect of soil has improved dramatically since the 19th century due to advances in agronomy and forestry and outcomes of the industrial revolution such as the development of synthetic fertilizer.

Soil is also an integral component of the natural landscape both in nature, including national parks, and in the urban landscape as the foundation for buildings, ornamental trees, and parks. It forms the physical links among all terrestrial landforms, from the highest mountains and slopes to the lowest floodplains, wetlands, and coastlines (i.e., its *landscape formation* ecological service function). Thus, the formation and transport of soil is essential for the development of a wide range of ecosystems that harbor diverse biota (fauna, flora, and microflora).

Although the agricultural productivity varies among regions, soil has been intensively managed in developed countries and some developing countries to support agriculture and forestry. Whether this management can continue to sustain a world population that has now reached 7.2 billion remains an open question. Soil science advances during the 20th century have contributed greatly to improving soil productivity, but additional improvements in soil's production aspects will be needed in the present century.

2. Current status and issues

Looking around the world, we can see risks to agricultural production caused by human ecosystem modifications and a range of anthropogenic and natural disasters, including depletion of water resources, soil degradation due to salinization, soil erosion, and pest outbreaks. Localized extreme weather events such as heat or cold waves, drought, and heavy rain are becoming more common, and are posing a growing threat to agricultural production. In Japan, the intensification of weather phenomena such as typhoons is now anticipated.

Soil pollution by toxic chemicals in and around urban areas and waste-disposal sites is gradually increasing, thereby preventing the use of this land and creating a need for land rehabilitation. In addition to these familiar problems, less-familiar problems such as the radioactive fallout from the Fukushima nuclear power plant accident have caused widespread soil contamination in a form that has made rehabilitation of the land and restoration of its production function difficult.

Traditionally, soils have changed relatively slowly (e.g., over periods of years or decades) in response to natural environmental changes, as well as to anthropogenic changes such as global warming and excesses or shortages of agricultural nutrients. However, some processes (e.g., landslides) can cause more rapid changes. If such rapid changes increase in frequency as a result of climate change, soil properties will change increasingly rapidly, possibly jeopardizing soil's production and landscape formation functions.

To cope with both gradual and rapid environmental changes, we need to improve our ability to manage soils so as to (i) increase the stability of ecosystems so that soils can provide sufficient water and nutrients to support flora, fauna, and microflora; (ii) sustain agricultural and forest productivity; and (iii) support conservation of the wider environment.

Based on the global recognition that soil functions need to be conserved and enhanced to cope with both slow and rapid environmental changes, the United Nations General Assembly declared 2015 to be the International Year of Soils and declared 5 December to be World Soil Day. To support this international effort, we have prepared a series of proposals to establish a knowledge base for soil science and promote society's understanding of both soil functions and the need for conservation.

3. Contents of the proposals

(1) Establish a national soil monitoring network to obtain the data required to update Japan's soil information system and reinforce Japan's contribution to the international community.

A primary center for soil resources should be established by the government to monitor and respond to the slow and rapid environmental changes that will occur throughout Japan.

A soil monitoring network should be established throughout Japan, with particular attention paid to establishing a strong north-to-south environmental gradient to account for the country's diverse environments. This should be achieved by establishing multiple research centers in each region and by developing an integrated soil information system that accounts for human activities, which are major factors that modify the environment.

Members of government administrative agencies and researchers at universities and research institutes should comprehensively recognize soil as an integrated system rather than preserving the conventional perspective, in which soils are divided into separate systems based on land use (e.g., agricultural versus forest versus urban soils). Soil information in Japan should be updated based on international standards, and Japan should strengthen its contribution to the global soil science community.

(2) Advance the frontiers of soil science and strengthen soil education.

Soil science, as a field of study, must be renewed by identifying new frontiers and solving new challenges so we can better understand and conserve Earth's surface. To do so, it will be necessary to go beyond conventional agricultural science to identify new frontiers, such as developing global- and landscape-scale perspectives on soil functions and management that will replace the former site-oriented perspective. This should be achieved by recruiting scientists from related fields to create a more interdisciplinary approach, and by actively utilizing new ideas and tools generated by advances in soil physics, soil chemistry, and soil microbiology. At the same time, training of specialists in soil research and soil education should be strengthened.

In addition, soil education should be expanded at levels from elementary schools to high schools to nourish students' understanding of the importance of soil and the need for its conservation. The abovementioned soil monitoring network could support such education.

(3) Establish a Basic National Soil Conservation Act.

Despite clear evidence of soil's importance and how strongly soil is affected by human activities, soil is ignored by most people who are not direct stakeholders, such as farmers. To improve this situation, to achieve more sustainable soil management and conservation, to clarify the basic principles underlying soil-related policies, and to achieve these goals comprehensively, we strongly recommend the development of a "Basic National Soil Conservation Act". This legislation should clearly describe the principles of and general rules for soil conservation, including a recognition of the public nature of soils and their usage, so as to promote efforts to monitor the status of soils, obtain and disseminate new knowledge provided by soil monitoring, and to promote soil research and education efforts. This will be accomplished by educating Japan's citizens about the importance of their nation's soils.

Original in Japanese: www.scj.go.jp/ja/info/kohyo/pdf/kohyo-23-t223-1.pdf