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Preface: Build Key Research Infrastructures and Enhance Scientific and Technological Innovation Capability of Field Stations

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Foreword: Build Key Research Infrastructures and Enhance Scientific and Technological Innovation Capability of Field Stations

The paradigm of scientific research has changed profoundly. Technological innovations in evolution of the universe, structure of matter, and origin of life rely increasingly on the infrastructures with high precision and powerful functions. As an important pillar of the country, major technological infrastructures like the Beijing Electron Positron Collider, China Remote Sensing Satellite Ground Station, Shanghai Synchrotron Radiation Facility, and FAST have played an important role in helping China achieve scientific and technological self-reliance.

Built in the late 20th century, the Chinese Ecosystem Research Network (CERN) is one of the few major technological infrastructures in the field of ecology and environment in China, and it marks a successful attempt to construct major distributed technological infrastructure. Now CERN runs 44 ecological stations, with one comprehensive center and 5 sub-centers. Guided by the leading group and the Scientific Committee of CERN over the past 30 years and supported by 20 research institutes affiliated to the Chinese Academy of Sciences (CAS), over 10 000 researchers and postgraduates have carried out research under the framework of CERN, which promotes the rapid development of ecosystem ecology in China. Their research aids in agricultural development, ecological construction, environmental governance, and sustainable use of resources at national and local levels. Currently, CERN is on a par with the American and European ecosystem networks, with its own advantages, characteristics, and important international influence.

The future technological innovation of CERN should adhere to two golden practices. ① Long-term and continuous positioning observation based on unified monitoring indicators and standards should be carried out to reveal scientific laws that cannot be determined on a short time scale. For example, the National Field Observation and Research Station for Ningxia Shapotou Desert Ecosystem has accumulated soil-moisture monitoring data for over 50 years; the National Field Observation and Research Station for Henan Fengqiu Farmland Ecosystem has accumulated soil-fertilizer control test data for over 20 years. ② CERN has prominent network features. It relies on networked research to expand the spatial scale and uncovers scientific laws that cannot be revealed by a single field station through long-term observation.

We should notice that CERN still relies on small monitoring and observation instruments for innovation and owns few large infrastructures, lagging behind other fast-developing sub-disciplines. Therefore, on one hand, we must step up the establishment and implementation of Terrestrial Ecosystem Observation and Experiment Network of China (Kunmai Project). Efforts should be made to build a facility that combines surface site-transect-network with unmanned aerial vehicle-remote sensing for three- dimensional and long-term continuous monitoring of carbon, nitrogen, and water fluxes and cycling processes on multiple time and space scales. This will significantly aid in our comprehensive capabilities of field observation and experimental research. On the other hand, we must focus on the construction of key field infrastructure based on top-level design and make it a field research platform for multiple research institutes and different disciplines. Step by step, each field station can have at least one landmark facility aligned with the characteristics of the discipline studied at the station. Such facility, as the mainstay of the station, will significantly enhance its research capability and core competitiveness.

In 2015, the Scientific Committee of CERN selected 11 field stations including the Qingyuan Forest Ecosystem Observation and Research Station of CAS, the National Field Observation and Research Station for Ningxia Shapotou Desert Ecosystem, the National Field Observation and Research Station for Xinjiang Fukang Desert Ecosystem, the National Field Observation and Research Station for Hebei Luancheng Farmland Ecosystem System, the National Field Observation and Research Station for Jiangsu Taihu Lake Ecosystem, the National Field Observation and Research Station for Hubei Donghu Lake Ecosystem, and the National Field Observation and Research Station for Shandong Yucheng Farmland Ecosystem (another 6 field stations were selected later) to build Qingyuan Multi-tower Platform, Shapotou Large-scale Heavy Lysimeter Cluster, and Online Multi-component Monitoring Platform of Wuhan Donghu Lake.

In 2019, I participated in the acceptance of the Qingyuan Multi-tower Platform Project and was impressed by the fruitful achievements. This project integrates many types of facilities to obtain real-time data with high precision and at high frequency. This broadens the breadth and depth of research and upgrades qualitative research to quantitative research, model simulation, sophisticated description of ecological processes, and forecasting research, comprehensively improving the research capability of Qingyuan Station. This progress lays a solid foundation for development in the next 5–10 years.

We can improve our work and attract experts in the interested fields to launch joint research with different levels of data products by fully summarizing the practices, results, and experience in the construction of key technological infrastructures, such as field control experiment platforms and field experimental facility for physical simulation, and by introducing and publicizing them to our peers at home and abroad. We sincerely invite young scientists to make use of these facilities, promote the continued construction of key field technological infrastructures in field stations, and drive high-quality development of the field technologies of CAS and even the whole country.

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