中国科学院
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Enabling ecological civilization through the support from science and technology

Ya-ping ZHANG | Vice President, Chinese Academy of Sciences

30th March, 2022

For NAC 2022

中国科学院
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Part 01

Building resilience

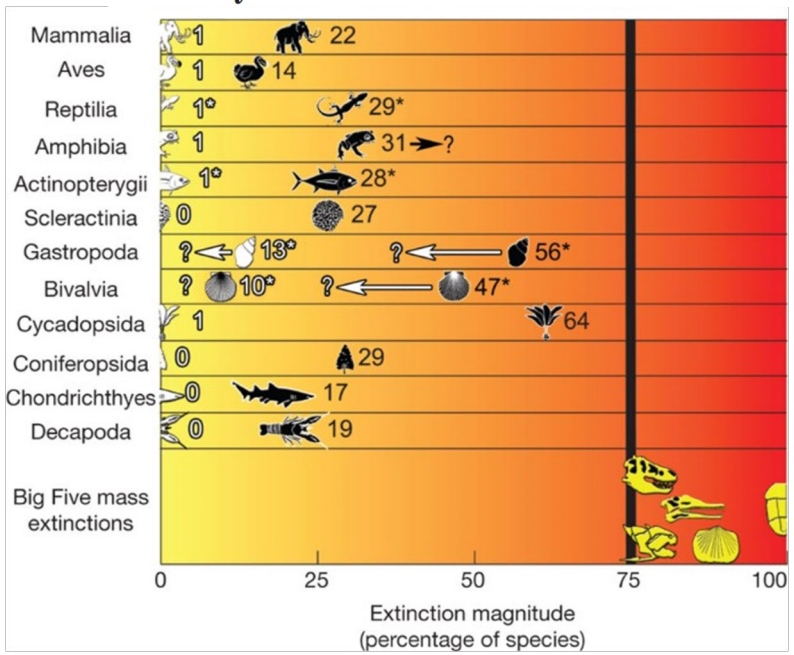
- Changing nature of risks
- Resilience and transformation
- Ecological civilization

For NAC 2022

01

The changing nature of risks

Has the Earth's sixth mass extinction already arrived?



More than 38,500 species are threatened with extinction

That is still 28% of all assessed species.

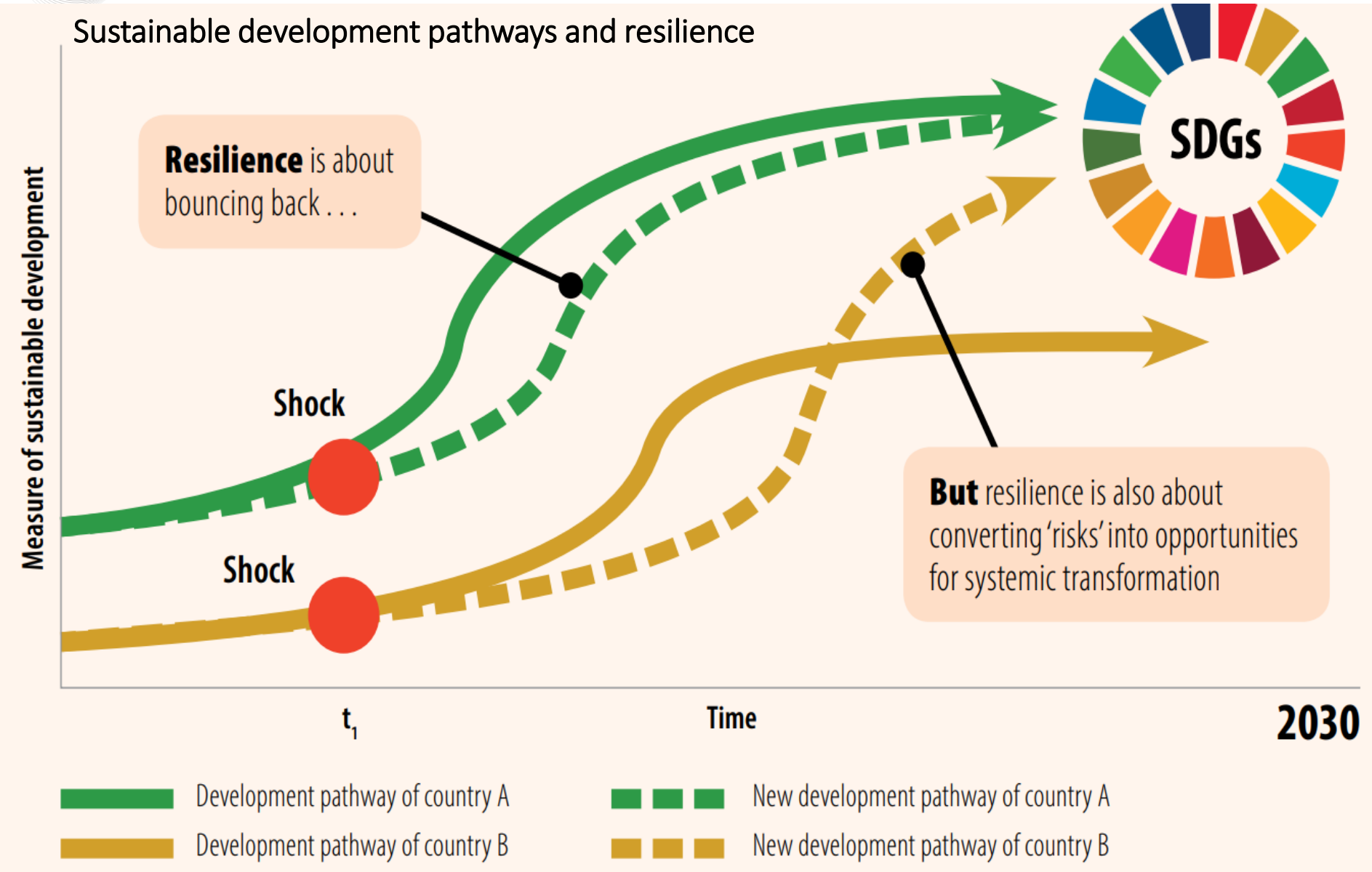
THE IUCN RED LIST OF THREATENED SPECIES™

AMPHIBIANS	MAMMALS	CONIFERS	BIRDS	SHARKS & RAYS	REEF CORALS
41%	26%	34%	14%	37%	33%

SELECTED CRUSTACEANS
28%

02 Bouncing back better: resilience and transformation

Sustainable development pathways and resilience



Source: ***Transformation towards sustainable and resilient societies in Asia and the Pacific***

03 Building resilience: time for transformation

Integrate nature conservation, climate change mitigation, and sustainable management of land and oceans in order to speed up the achievement of SDGs. Development of coherent, science-based action targets is paramount in addressing major global issues such as biodiversity loss and climate change.

Space for nature

Science 14 Sep 2018:
Vol. 361, Issue 6407, pp. 1051

EDITORIAL

tions of an underestimate, we encourage governments to set minimum targets of 30% of the oceans and land protected by 2030, with a focus on areas of high biodiversity and/or productivity, and to aim to secure 50% by 2050. This will be extremely challenging, but it is

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Science
AAAS

vertebrates and plants are threatened with extinction, mostly because humans have degraded or converted more than half of the terrestrial natural habitat. Moreover, we are harnessing biomass from other forms of life and converting it into crops and animals that are more useful to us. Livestock now constitute 60% of the mammalian biomass and humans another 36%. Only 4% remains for the more than 5000 species of wild mammals. This ratio is not surprising: Wild vertebrate populations have declined by more than 50% since 1970. Both from an ethical and a utilitarian viewpoint, this depletion of natural ecosystems is ex-

Spix's macaw, native to Brazil, is critically endangered.

"Current levels of protection do not even come close to the required levels."

Target states that by 2020, at least 17% of the terrestrial and inland water, and 10% of coastal and marine areas, should be conserved. Target 12 advocates for preventing extinction of known species, and Target 14 advocates for the safeguarding of ecosystems that provide essential services. These goals beg the question: Would achieving Target 11 be sufficient to allow the achievement of Target 12 or 14? Current scientific evidence suggests that it would be woefully inadequate for the task.

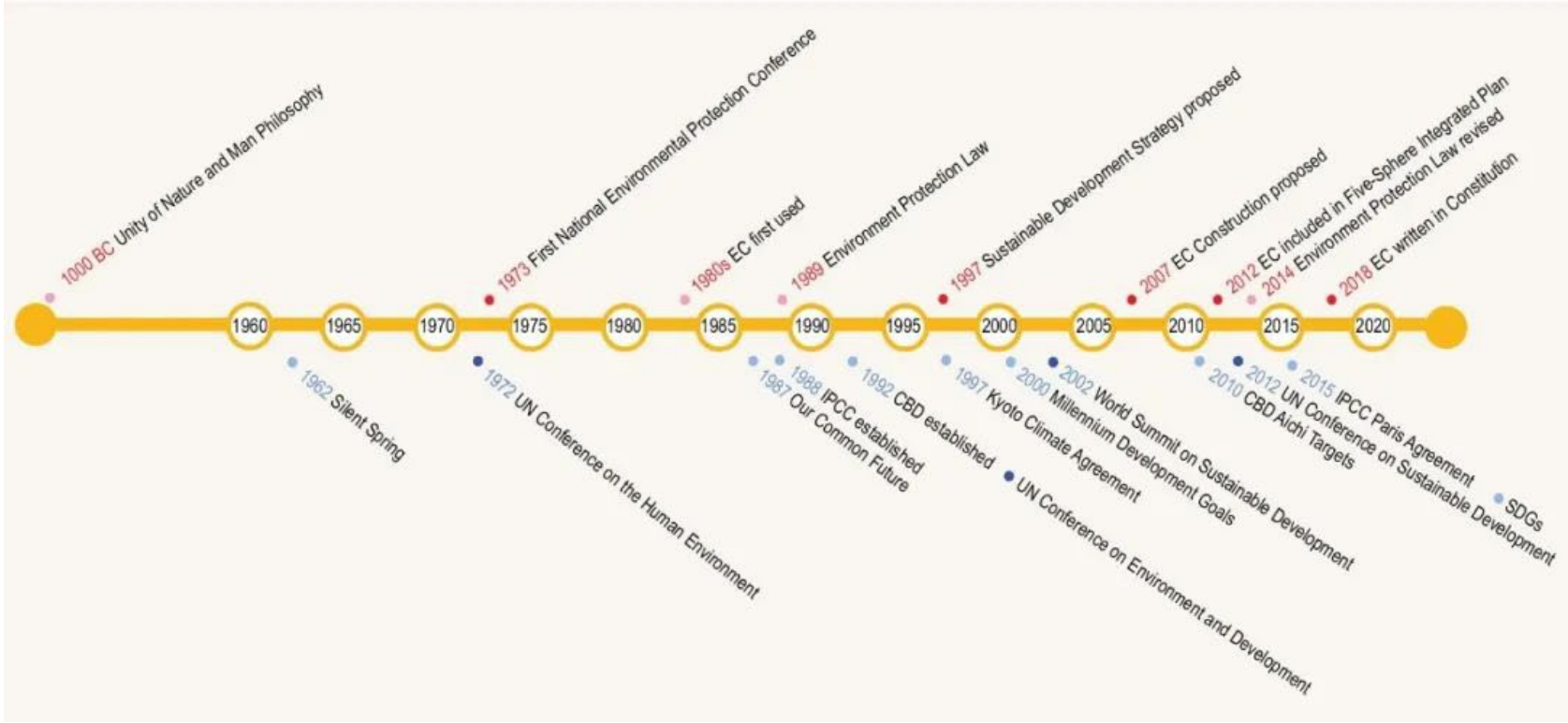
If we truly want to protect biodiversity and secure critical ecosystem benefits, the world's governments must set a much more ambitious

Wei F et al. 2020. *National Science Review*

03 Building resilience： ecological civilization

Ecological civilization: China's effort to build a shared future for all life on Earth

Fuwen Wei [1,2,3,*], Shuhong Cui[4], Ning Liu[4], Jiang Chang[5], Xiaoge Ping[6], Tianxiao Ma [1], Jing Xu[5], Ronald R. Swaisgood[7] and Harvey Locke[8,9]



The timeline of the development of the Ecological civilization concept in China (above) and of sustainable development globally (below).

中国科学院
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Part
02

CAS Actions

- Enhancing resilience
- Ecosystem restoration
- Documenting biodiversity
- Science research
- Platform development

For NAC 2022

CAS actions

Our research and resources now align to five actions, to help us achieve transformative change and maximum positive impact.

Action 1

- **Enhancing Resilience**

Assessing ecosystem functions and services, to help conservation, increase resilience to global risks and explore benefits for human health and well-being.

Action 2

- **Ecosystem Restoration**

Conducting innovative projections into protection of biodiversity and ecosystem services, while seeking nature-based solutions to societal challenges.

Action 3

- **Documenting Biodiversity**

Integration of data systems to accelerate identification of species and increase the global value of CAS collections for science, conservation and education.

Action 4

- **Science Research**

Push the frontiers of research to understand biodiversity maintenance mechanism to aid protection of biodiversity and enhance resilience to risk.

Action 5

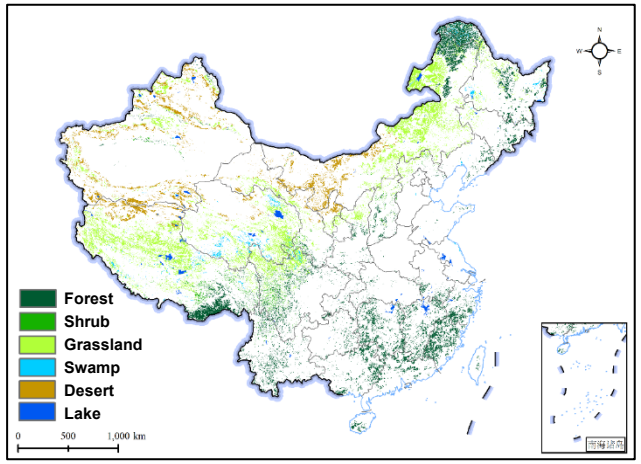
- **Platform Development**

Building research networks and using bigdata and new technologies to innovative interdisciplinary cooperation and maximize scientific support for resilience.

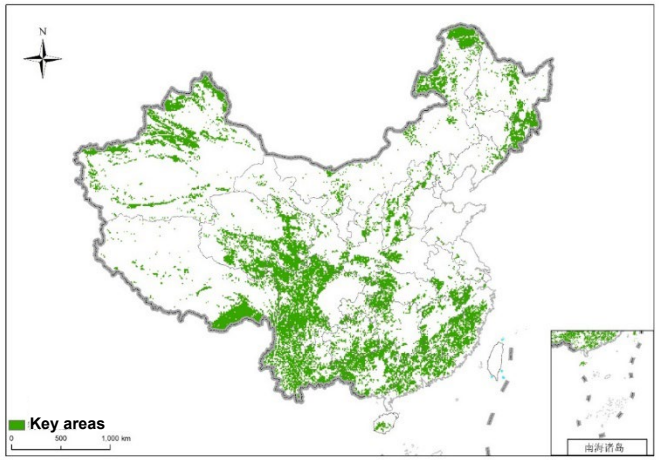
01

Enhancing resilience to risks

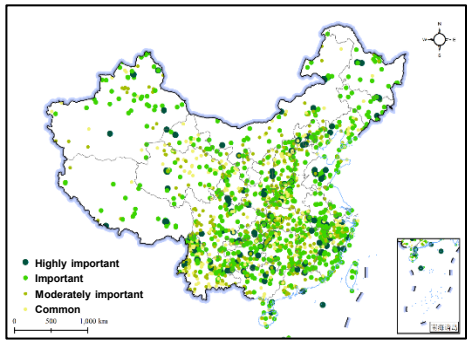
1.1 National Park Planning



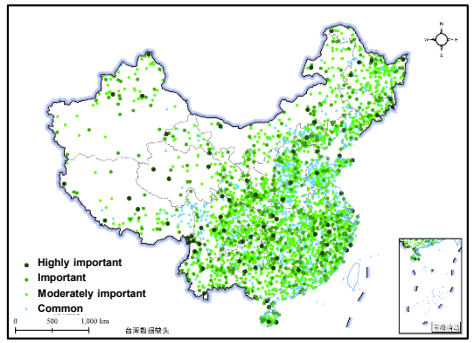
Ecosystem conservation priorities



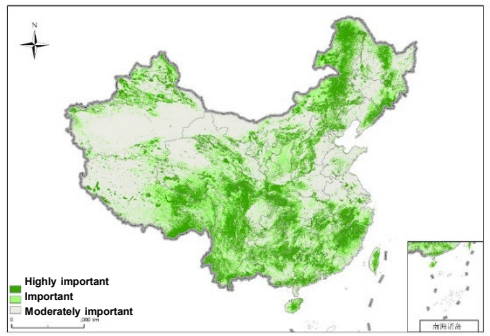
Key protected species



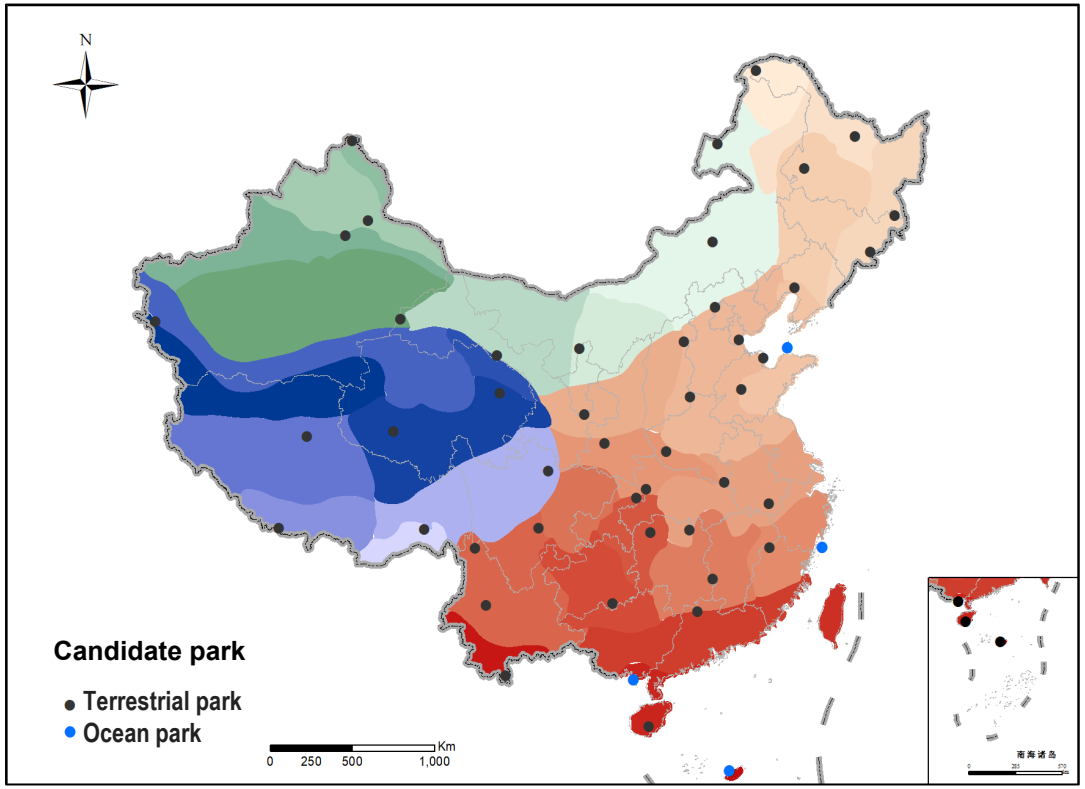
Important natural relics



Important natural landscapes



Ecosystem services

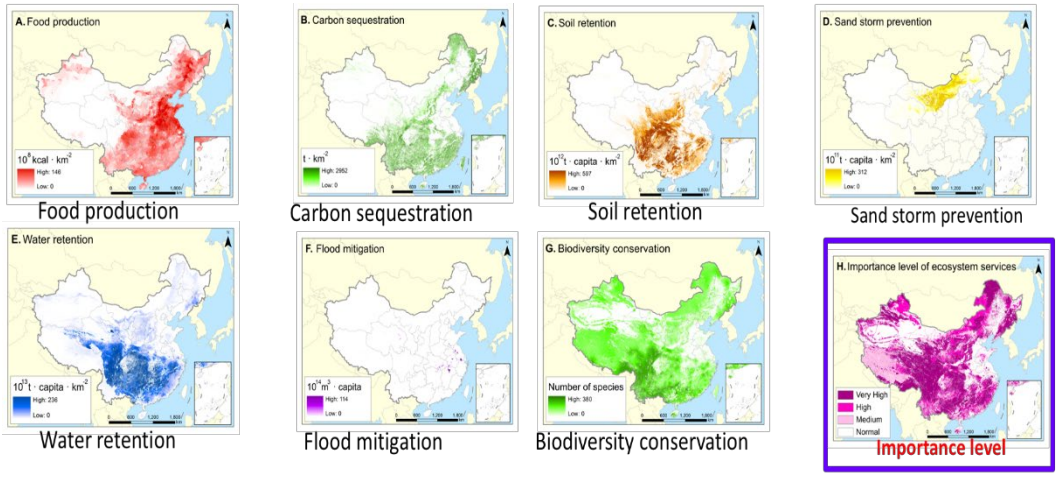


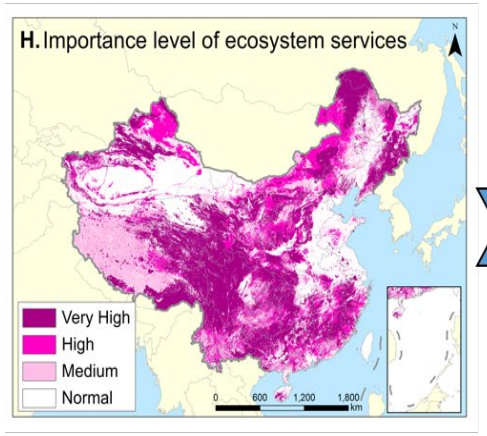
National parks planning

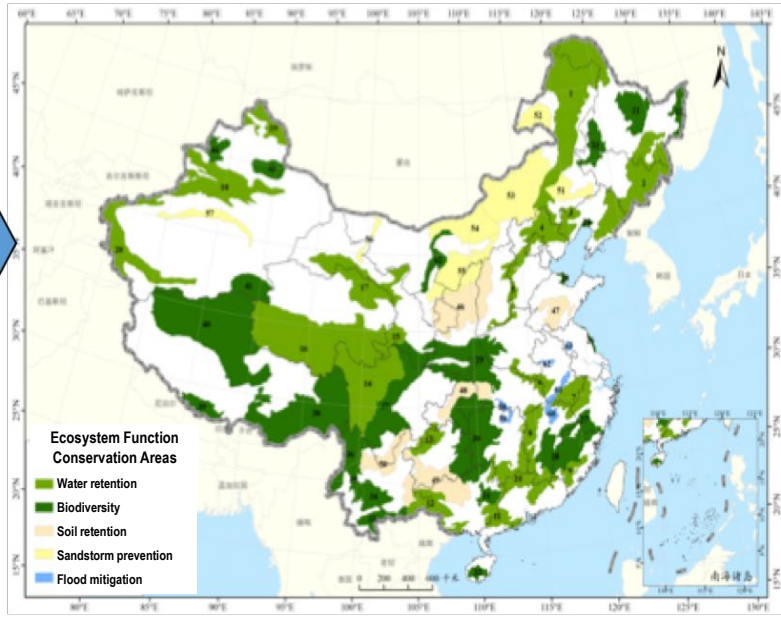
01 Enhancing resilience to risks

1.2 Ecosystem Assessment

CAS has taken the lead in assessing ecosystem service functions, specifying spatial patterns and key areas for protection, and supporting the planning of national ecological function zones, key ecological function zones, and spatial layout of national parks.







- 63 areas with critical ecosystem services were identified as Ecosystem function conservation areas (EFCAs) released in 2015 by MEP and CAS.
- Total 63 EFCAs, 49% of China.

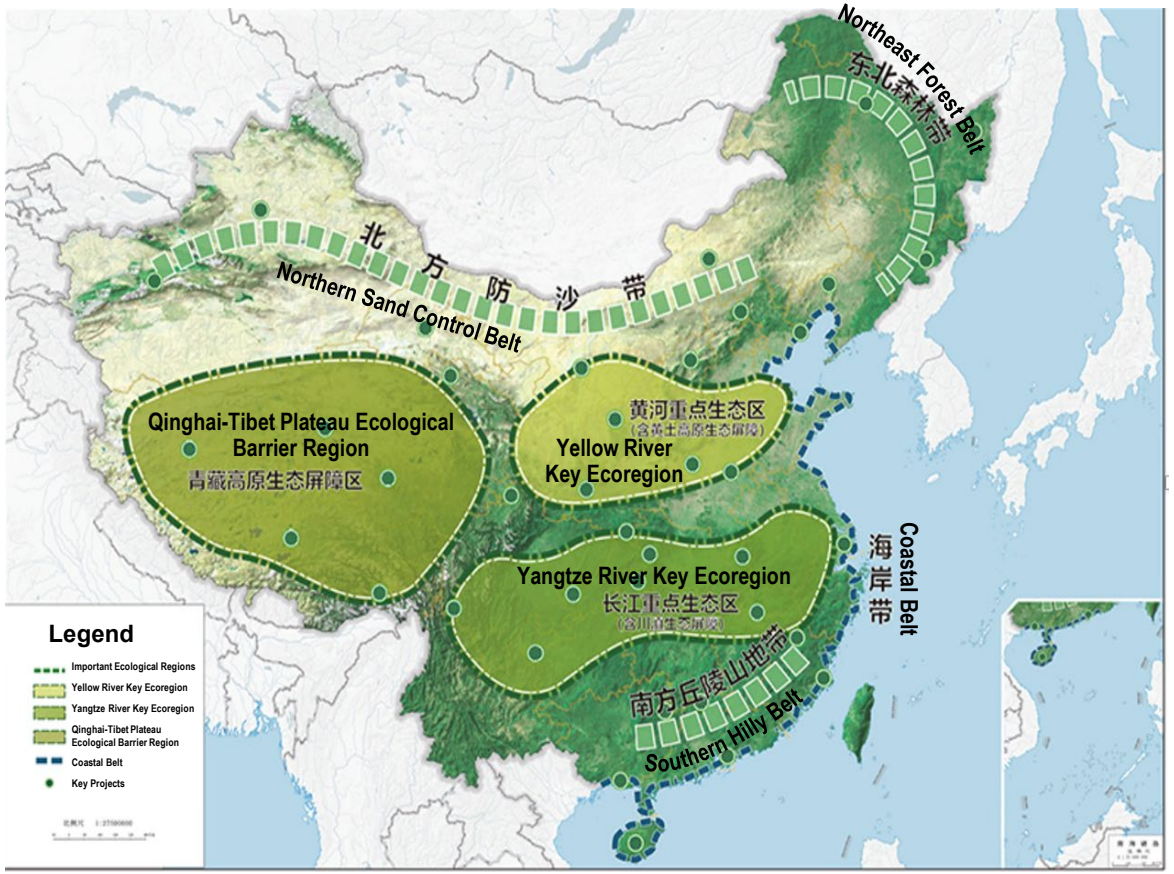
Science AAAS

Ouyang Z Y, Zheng H, Xiao Y, et al. Improvements in ecosystem services from investments in natural capital. Science, 2016, 352: 1455-1459.

02

Building resilience using ecological restoration

2.1 Scientific assessment on national ecological engineering projects



Major Ecological Projects for the protection and restoration of ecosystems

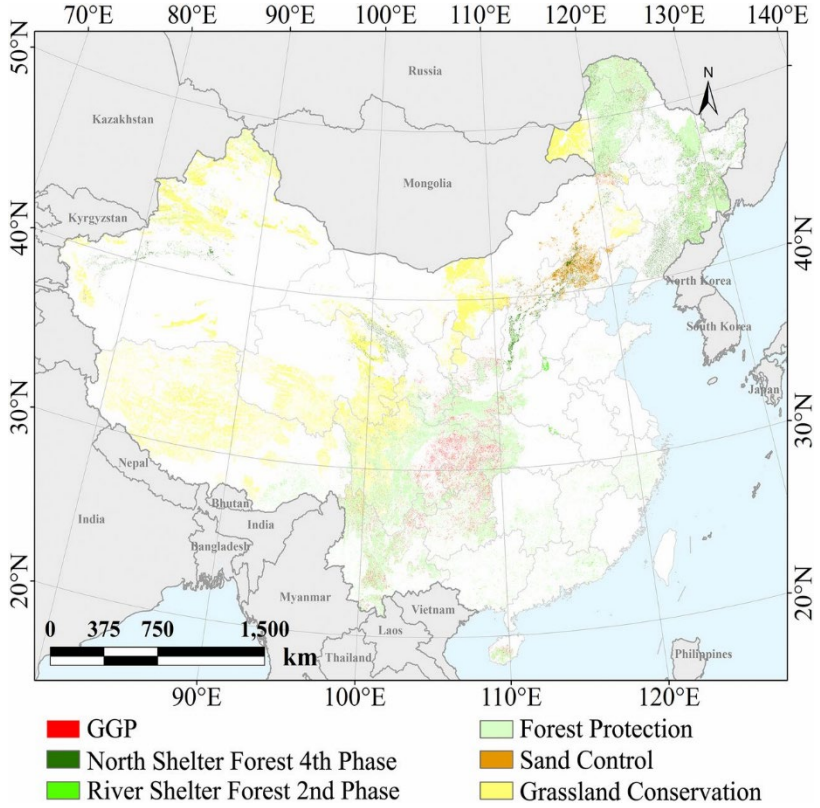
- CAS conducted a comprehensive evaluation of the construction of the Three North Project in the past 40 years.
- The evaluation report includes the completion of the 40-year plan, the current achievements, existing problems and countermeasures.

02

Building resilience using ecological restoration

2.2 CASE STUDY: China's ecological restoration projects have significantly increased ecosystem carbon sinks

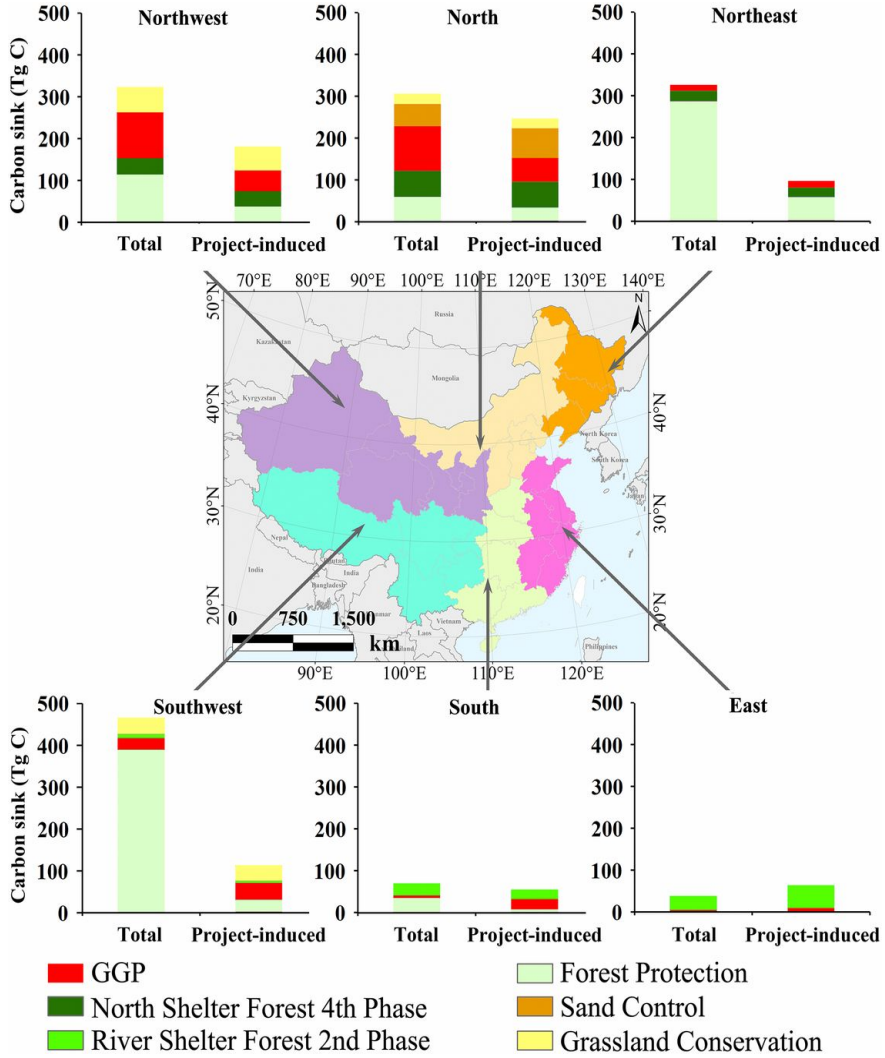
- "Key Ecological Engineering Carbon Sequestration Assessment" project undertaken by CAS and others reveal that key ecological projects implemented in China have significantly improved the carbon storage and carbon sink functions and played a huge carbon sequestration effect.
- Biodiversity and its conservation can therefore contribute to the mitigation of climate change and are an important part of **nature-based solutions**.



Location of six key ecological restoration projects in China.

PNAS

Lu F et al. Effects of national ecological restoration projects on carbon sequestration in China from 2001 to 2010. PNAS 2018; 115: 4039–44.



Decadal ecosystem and project-induced C sinks in six geographical regions of China

03

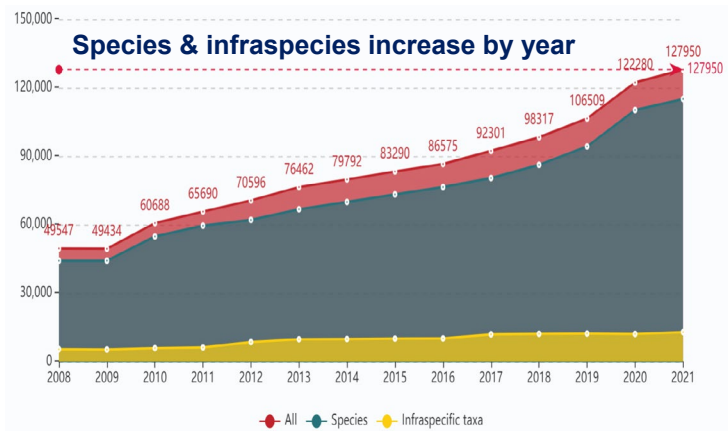
Documenting biodiversity

3.1 Bioinventory and redlisting of biodiversity

Flora Reipublicae Popularis Sinicae; **80 volumes, 126 books**

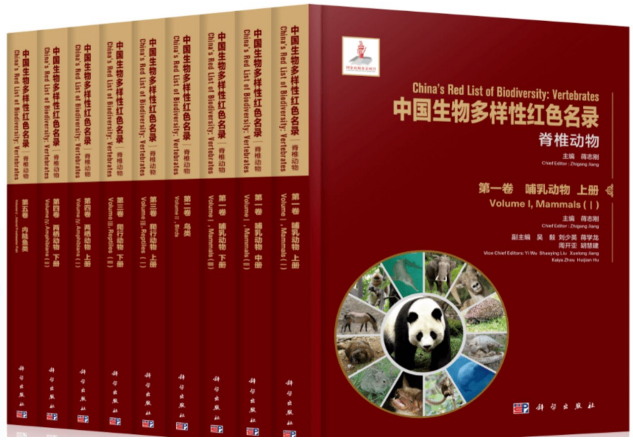
Fauna Sinica; **162 volumes**

Flora of fungi in China; **59 volumes**



Since 2008, *Catalogue of Life China* has been updated annually by CAS with 2,000 new species published each year.

Totally, 128,000 species and infraspecies have been included in 2021 version.

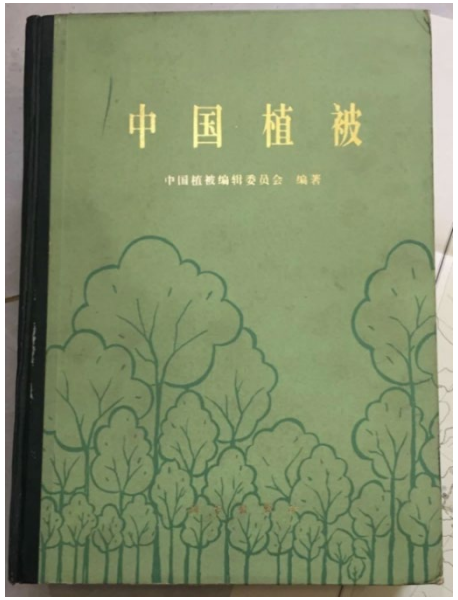


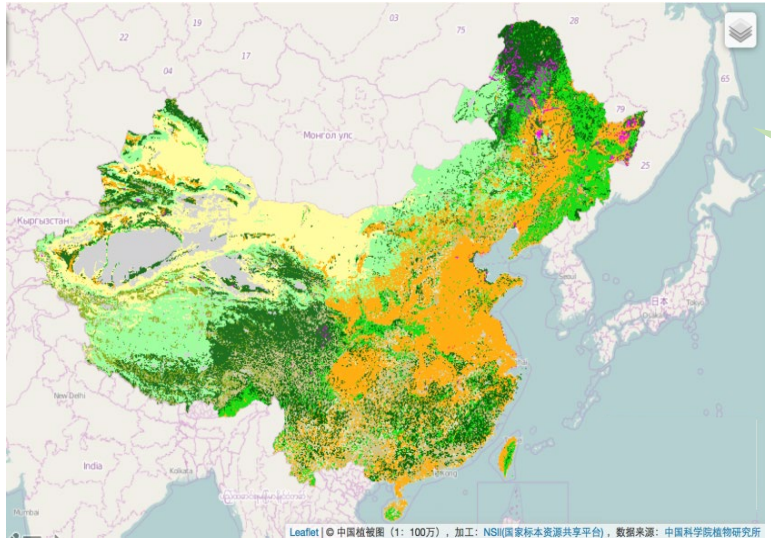
China's Red List of Biodiversity **provides a scientific basis for the formulation of biodiversity conservation policies and plans, and a data base for conducting scientific research on biodiversity.**

03

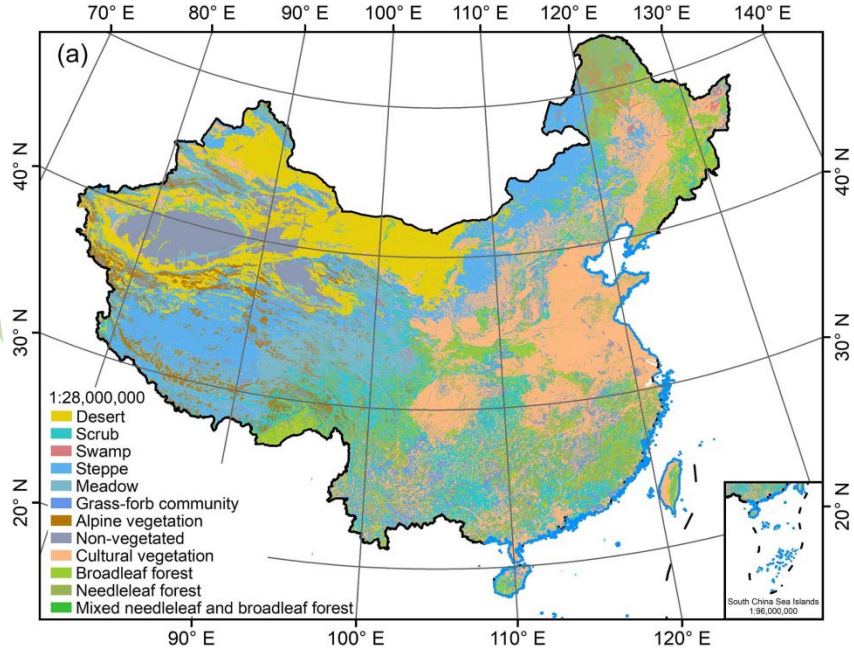
Documenting biodiversity

3.2 Update China Vegetation to Vegetation Map





China vegetation map (1:1 000 000) **includes 11 vegetation type groups, 55 vegetation types, 960 vegetation groups and subgroups in China**



Updated Vegetation Map (2020); **Su et al. *Science Bulletin*, 2020, 65: 1125-1136**

Published in 1980, the book is divided into 35 chapters, with a map of *China Vegetation and Vegetation Regionalization Map of China*

03

Documenting biodiversity

3.3 2nd Tibetan Plateau Scientific Expedition

- Over the past four years, the second Qinghai-Tibet scientific research team has made full use of modern high technology to carry out scientific research, and a series of scientific research results have strongly supported the construction of national ecological civilization. The research found that the sum of glacier reserves, lake water volume and runoff of major rivers out of the Asian Water Tower exceeded 9 trillion cubic meters, providing important scientific support for the national water conservation strategy.

Floatplane lifts to 7000m+ for water vapor process observations

Using drones to observe glacier topography

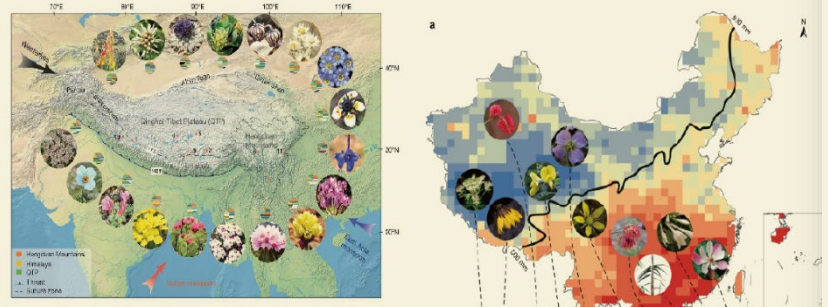
Unmanned boats to measure the volume of water in lakes

04 Biodiversity science research

ORIGIN AND EVOLUTION OF BIODIVERSITY

中国是生物多样性的“摇篮”和“博物馆”。许多生物区系的起源都与青藏高原及周边地区的隆升、东亚季风的形成及西部地区干旱化等密切相关。横断山是高寒物种起源和分化的摇篮，也丰富了喜马拉雅山和青藏高原地区的植物多样性。中国东部湿润和半湿润地区具有较早分化类群，中国区系66%的属都出现在2300万年前的早中新世之后，东亚是许多古老子遗植物的避难所。生物物种可以通过可塑性变化和适应性进化以及迁移等响应气候变化和其他环境因素的变化。

China is both the ‘cradle’ and ‘museum’ of biodiversity. The origin of many biota is closely related to the uplift of the Qinghai-Tibet Plateau and surrounding areas, the formation of the East Asian monsoon, and the aridity in the western region. The Hengduan Mountains are the ‘cradle’ of the origin and diversification of alpine species and have contributed to the floristic diversity in the Himalayas and the Qinghai-Tibet Plateau. The humid and semi-humid regions of eastern China have early diverging taxa, with 66% of the genera in the Chinese flora emerging after early Miocene epoch (23 million years ago). East Asia provided refugia for many ancient relict plants. Species can respond to changes in climate and other environmental factors through phenotypic plasticity, adaptive evolution, and migration.



青藏高原-横断山区地形图及所选研究对象

Topographic map of the Tibet-Himalaya-Hengduan (THH) region and distribution of studied plant taxa. (Ding *et al.* 2020. Science 369: 578-581).

东亚植物区系的来源

Geographical origins of the East Asian flora (Chen *et al.* 2017. Natl. Sci. Rev. 5: 920-932).

中国被子植物时空分化格局

Spatio-temporal divergence patterns of the Chinese angiosperm flora (Lu *et al.* 2018. Nature 554: 234-2

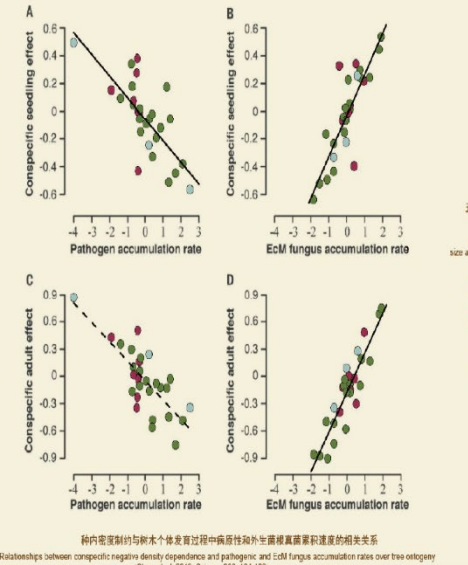
MAINTAINING MECHANISMS OF BIODIVERSITY

在物种丰富的地区，多个共享相似资源的物种如何在局域群落内共存一直是生态学的核心问题。由于种内资源竞争或同种个体间病虫害的传播和捕食者的转换造成种内个体之间的负相互作用，即同种密度制约，是生物多样性维持的重要机制，多营养级种间互作或在决定群落多样性方面有重要作用。例如，有益外生菌根真菌能够降低植物同种密度制约的强度，而病原真菌则相反。

根据对脊椎动物遗传多样性的研究，大多数物种的快速种群下降发生在近期，如果采取一定的保护措施，受威胁种群是有望恢复的。对于大熊猫来说，异常低的能量代谢可能是对其食性特化的一种适应。

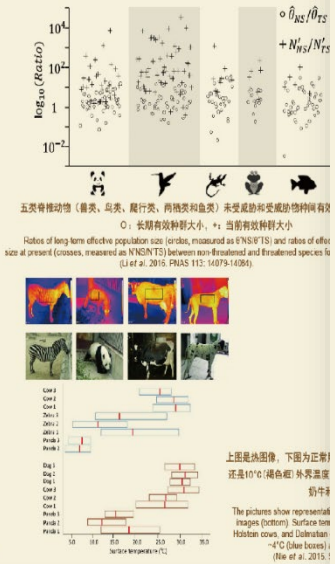
The coexistence of multiple species sharing similar resources within local communities in a species-rich area has always been the core issue in ecology. The conspecific negative density dependence (CNDD) that is caused by negative interactions between individuals within species, due to intraspecific competition for resources or transmission of diseases, pests, and predators among individuals of the same species, is assumed to be an important mechanism for maintaining biodiversity. Multi-trophic interspecific interactions may play an important role in determining community biodiversity. Mutualistic ectomycorrhizal fungi (opposite to pathogenic fungi) could reduce the strength of CNDD.

Rapid population decline of many vertebrate species began in the late 19th century, indicating that threatened populations could be achieved to recover if certain conservation measures are taken. For bamboo-eating giant pandas, the exceptionally low daily energy expenditure may be a mechanism of adaptation to their special diet.



种内密度制约与树木个体发育过程中病原性和外生菌根真菌累积速度的相关关系

Relationships between conspecific negative density dependence and pathogenic and EcM fungus accumulation rates over tree ontogeny (Chen *et al.* 2019. Science 366: 124-128).



五类脊椎动物（兽类、鸟类、爬行类、两栖类和鱼类）未受威胁和受威胁物种间有效

O：长期有效种群大小，+：当前有效种群大小

Ratios of long-term effective population size (circles, measured as θNS/θTS) and ratios of effe
size at present (crosses, measured as NNS/NTS) between non-threatened and threatened species fo
(Li *et al.* 2015. PNAS 112: 14079-14084).

上图是热图像，下图为正常

还是10°C（褐色框）外界温度

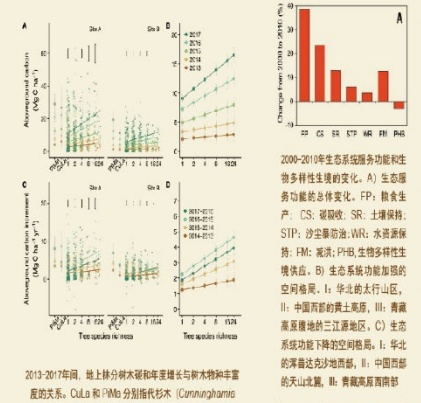
奶牛

The pictures show representati
images (bottom). Surface tem
Holstein cows, and Dalmatian
~4°C (blue boxes)
(Nie *et al.*, 2015.

BIODIVERSITY AND ECOSYSTEM FUNCTIONING AND SERVICES

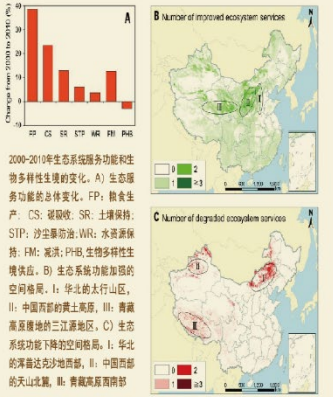
物种多样性可以提高植物群落的生产力和抵御收，说明生物多样性及其保护能够为减缓气候变化的影响做出贡献。保护生物多样性能够改善生态系统服务，中国政府的保护政策显著地提升了生态系统服务。对旗舰物种的保护可以扩大保护成效，同一生态系统的其他物种也会受益。例如，大熊猫及其保护区提供的生态系统服务价值高出保护成本10倍以上。生态系统服务付费补偿能很好地权衡提供者和受益者的利益，减轻人类活动对自然生态系统的压力。

Species diversity can increase primary productivity and carbon fixation of plant communities, suggesting that biodiversity and its conservation can mitigate the impacts of climate change, as well as providing other valuable ecosystem services. Conservation policy of the Chinese government significantly increases certain ecosystem services in China. Conservation of flagship species and their habitats can also serve as an umbrella to protect other species in the same ecosystem, thus enhancing conservation effectiveness. For example, the value of ecosystem services provided by giant pandas and their protected areas is more than 10 times higher than the investment. The payments for ecosystem services (PES) can reconcile the interests of ecosystem service providers and the beneficiaries, and reduce the pressure of human activities on natural ecosystems.



2013–2017年间，地上林分树木碳和年度增长与树木物种丰富度的关系。CuLa 和 PiMa 分别指代杉木（*Cunninghamia lanceolata*）和马尾松（*Pinus massoniana*）人工林

Aboveground stand-level tree carbon (A, B) and its annual increment (C,D) as a function of tree species richness from 2013–2017.
PiMa = *Pinus massoniana* monoculture plantation;
CuLa = *Cunninghamia lanceolata* monoculture plantation.
(Huang *et al.* 2018. Science 362: 80-83)



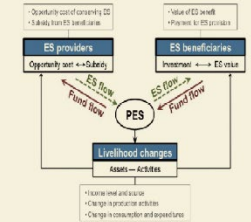
2000–2010年生态系统服务功能和生物多样性生境的变化。A）生态服务功能的 β 体变化。FP：粮食生产；CS：碳贮收；SR：土壤保持；STP：沙尘暴防治；WR：水资源保持；FM：减洪；PHB：生物多样性生境供应。B）生态系统功能加强的空间格局。I：华北的太行山区，II：中国西部的黄土高原，III：青藏高原腹地的三江源地区，C）生态系统功能下降的空间格局。I：华北的浑善达克沙地西部，II：中国西部的天山北麓，III：青藏高原南部

Improvement in ecosystem service provision and decline in habitat for biodiversity in China from 2000 to 2010. A) Aggregate change in provision of ecosystem services, for the seven focal ecosystem services; FP, food production; CS, carbon sequestration; SR, soil retention; STP, sandstorm prevention; WR, water retention; FM, flood mitigation; and PHB, provision of habitat for biodiversity. B) Spatial pattern of ecosystem service increases. (I) Taihang Mountains in north China; (II) Loess Plateau in western China; (III) Sanjiangyuan area in the center of the Tibetan Plateau. C) Spatial pattern of ecosystem service decreases. (I) Western Otindag Sandy Area in northern China; (II) Northern Tianshan Mountains in western China; (III) Southwestern Tibetan Plateau.
(Ouyang *et al.* 2016. Science 352: 1455-1459).

表2011–2030年不同情景下大熊猫保护的价值

Table Costs and Benefits of the Giant Panda Protection for Different Scenarios, from 2011–2030.
(Wei *et al.* 2018. Curr. Biol. 28: 2174–2180).

情景 Scenario	年均成本（百万美元） Total Costs/Year (USD, Million/Year)	年均收益（百万美元） Total Benefits/Year (USD, Million/Year)	成本和收益比值 Benefit/Cost Ratio
情景1：维持现有生境 Scenario 1: Maintain management of current habitat	255	2688	10. 2
情景2：提高人力配置下改善现有生境管理 Scenario 2: Improve management of current habitat by 15% through ideal personnel allocation	271	2893	10. 7
情景3：通过扩大保护地和改善现有保护地管理，增加15%生境面积 Scenario 3: Enlarge the habitat area by 15% through expanding reserves and improving management by 15%	292	3239	11. 0
情景4：由于经济和退耕还林等保护政策、人力和以及集体林的减少，生境退化20% Scenario 4: Habitat degradation by 20% due to economic slowdown and decreases in conservation investment, personnel, and collective forest	228	1924	8. 4



生态系统服务付费与生态系统服务功能的评估框架

Assessment framework for payments for ecosystem services
(Zheng *et al.* 2013. PNAS 110: 16681-16686).

05

Platform Development

科学数据中心（SDC）
Science Data Center

- 中国科学院植物科学数据中心
  CAS Plant Science Data Center
- 国家青藏高原科学数据中心
  National Tibetan Plateau Data Center
- 国家微生物科学数据中心
  National Microbiology Data Center
- 中国科学院地球大数据中心
  CAS Science Data Center for Big Earth Data
- 国家基因组科学数据中心
  National Genomics Data Center
- 中国科学院海洋科学数据中心
  CAS Oceanographic Data Center
- 国家生态科学数据中心
  National Ecosystem Science Data Center

中国生态系统研究网络（CERN）
Chinese Ecosystem Research Network (CERN)

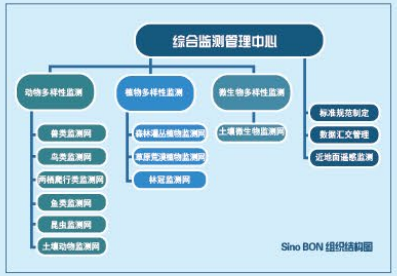
该研究网络由 15 个农田生态系统试验站、12 个森林生态系统试验站、2 个草地生态系统试验站、6 个沙漠生态系统试验站、2 个沼泽生态系统试验站、3 个湖泊生态系统试验站、3 个海洋生态系统试验站、1 个城市生态站，以及水分、土壤、大气、生物、水域生态系统 5 个学科分中心、1 个综合研究中心和 1 个数据中心所组成。

Chinese Ecosystem Research Network (CERN) includes 15 agriculture stations, 12 forest stations, 2 grassland stations, 6 desert stations, 2 marsh stations, 3 lake stations, 3 bay stations and 1 urban station, as well as 5 disciplinary centers (sub-center for biology, soil, water, atmosphere and aquatic ecosystems), a synthesis research center and a data center.

中国生物多样性监测与研究网络（Sino BON）
China Biodiversity Observation and Research Network (Sino BON)

2013 年，在中国森林生物多样性监测网（CForBio）基础上，正式启动建设中国生物多样性监测与研究网络（Sino BON），包括动物多样性监测网、植物多样性监测网、微生物多样性监测网和 1 个综合监测管理中心。

In 2013, China Biodiversity Observation and Research Network (Sino BON) was officially launched on the basis of the Chinese Forest Biodiversity Monitoring Network (CForBio) including zoological diversity center, botanical diversity center and microbial diversity center, and a synthesis center.

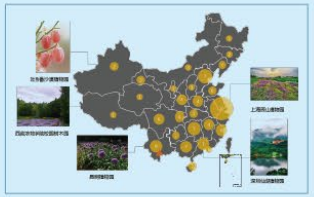


境外机构
Overseas Institutions

- 中国科学院
  东南亚生物多样性研究中心
  CAS Southeast Asia Biodiversity Research Institute
- 中国科学院
  中－非联合研究中心 CAS Sino-Africa Joint Research Center
- 中国科学院
  中亚生态与环境研究中心
  CAS Research Center for Ecology and Environment of Central Asia
- 中国科学院
  加德满都科教中心 Kathmandu Center of Research and Education, CAS-TU

中国植物园联盟（CUBG）
Chinese Union of Botanical Gardens (CUBG)

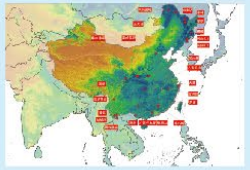
中国科学院联合国家林业和草原局、住房和城乡建设部和生态环境部共同建设中国植物园联盟。现有 118 家植物园成员单位，旨在促进植物园科学发展和规范建设，更好地服务于我国生态文明建设。



The Chinese Union of Botanical Gardens (CUBG) is sponsored by CAS, National Forestry and Grassland Administration (NFGA), Ministry of Housing and Urban-Rural Development (MOHURD), Ministry of Ecology and Environment (MEE). CUBG consists of 118 botanical gardens, and aims at promoting the development of botanical gardens and advancing the standard construction to better serve ecological civilization promotion.

中国森林生物多样性监测网络（CForBio）
Chinese Forest Biodiversity Monitoring Network (CForBio)

中国森林生物多样性监测网络，包括分布于北方林、针阔混交林、落叶阔叶林、常绿落叶阔叶混交林、常绿阔叶林以及热带雨林等多种森林类型中的样地和研究设施。CForBio 共建成 23 个 20 公顷左右的大型森林动态样地和 1 个样地群（30 个 1 公顷样地），以及近 60 个面积 1–5 公顷的辅助样地。



Chinese Forest Biodiversity Monitoring Network includes forest dynamics plots and research infrastructures in zonal forest types of cold temperate boreal forests, temperate coniferous and broadleaved mixed forests, warm temperate deciduous broadleaved forests, subtropical evergreen broadleaved forests and tropical rainforests. CForBio has established 23 permanent plots with the size around 20 ha and a plot group (30 plots with the size of 1-ha) and nearly 60 associated plots with the size of 1-5 ha.

05

Platform Development

5.1 Ex-situ conservation

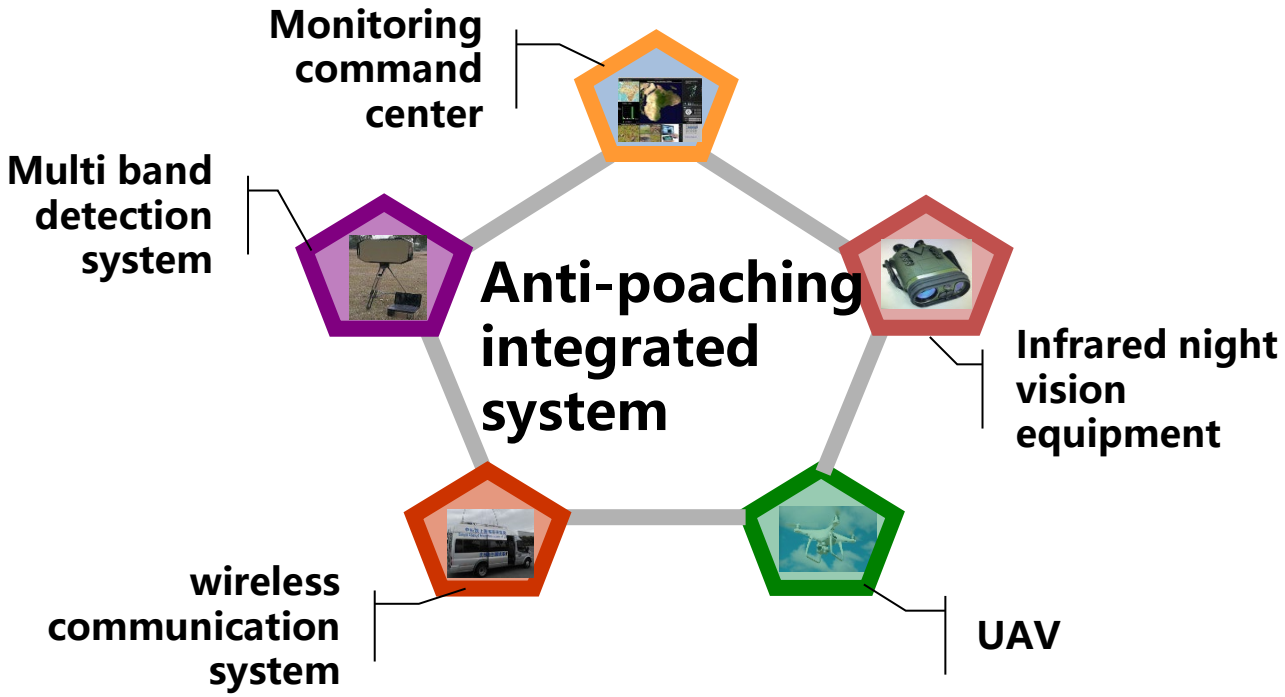
- The “Southwest China Wildlife Germplasm Repository” built by CAS is the only conservation facility focusing on the preservation of wildlife germplasm resources in China.
- It has preserved 10,601 species of plant seeds (36% flowering plant species in China), 85,046 copies; 2,093 species and 24,100 copies of plant ex vivo culture materials; 7,324 species and 65,456 copies of DNA; 2,280 species and 22,800 copies of microbial strains and 2,203 species and 60,262 copies of animal germplasm resources.
- As the largest wildlife germplasm repository in Asia, the germplasm bank has become a global leader in biodiversity conservation, together with the Millennium Seed Bank in the UK and the Svalbard Global Seed Bank in Norway.




05

Platform Development

5.2 New technology revolution

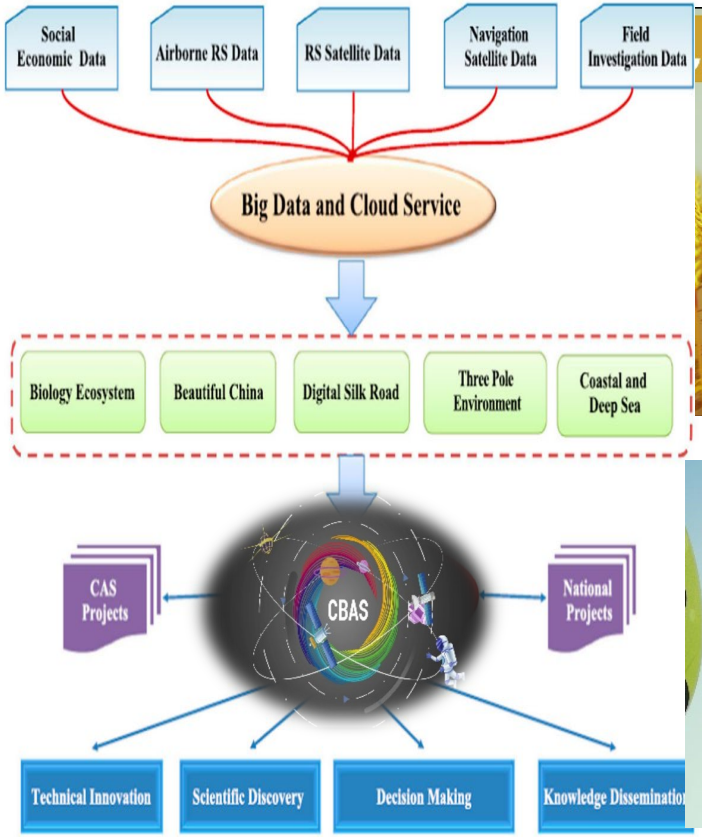


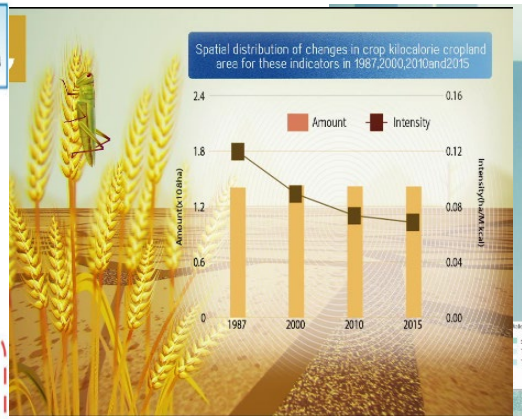
- In 2016, CAS developed the anti-poaching equipment and integrated application systems to combat illegal trade in wildlife plants, especially the poaching of endangered species such as elephants and rhinos on the African continent.

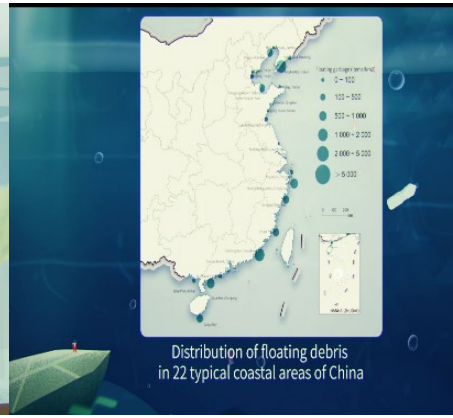
05

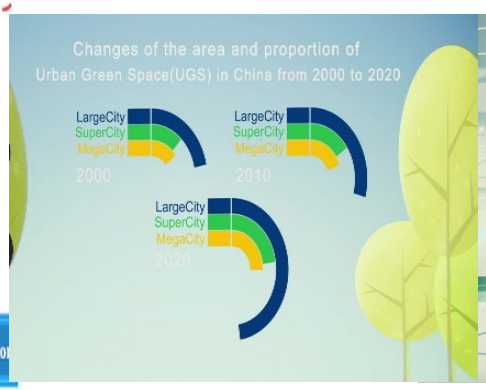
Platform Development

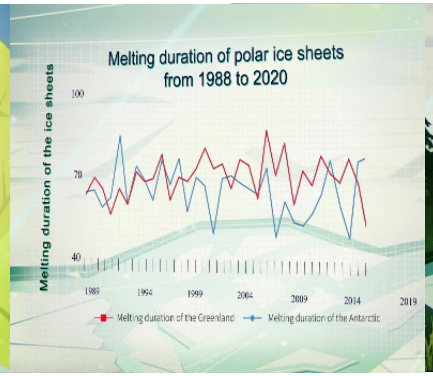
5.3 International Research Center of Bigdata for SDGs

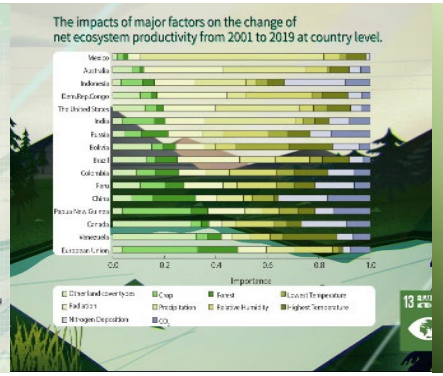


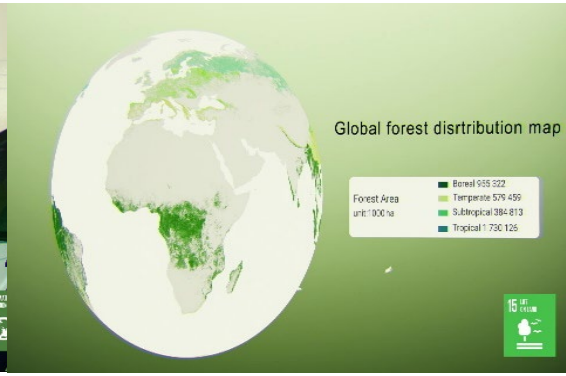




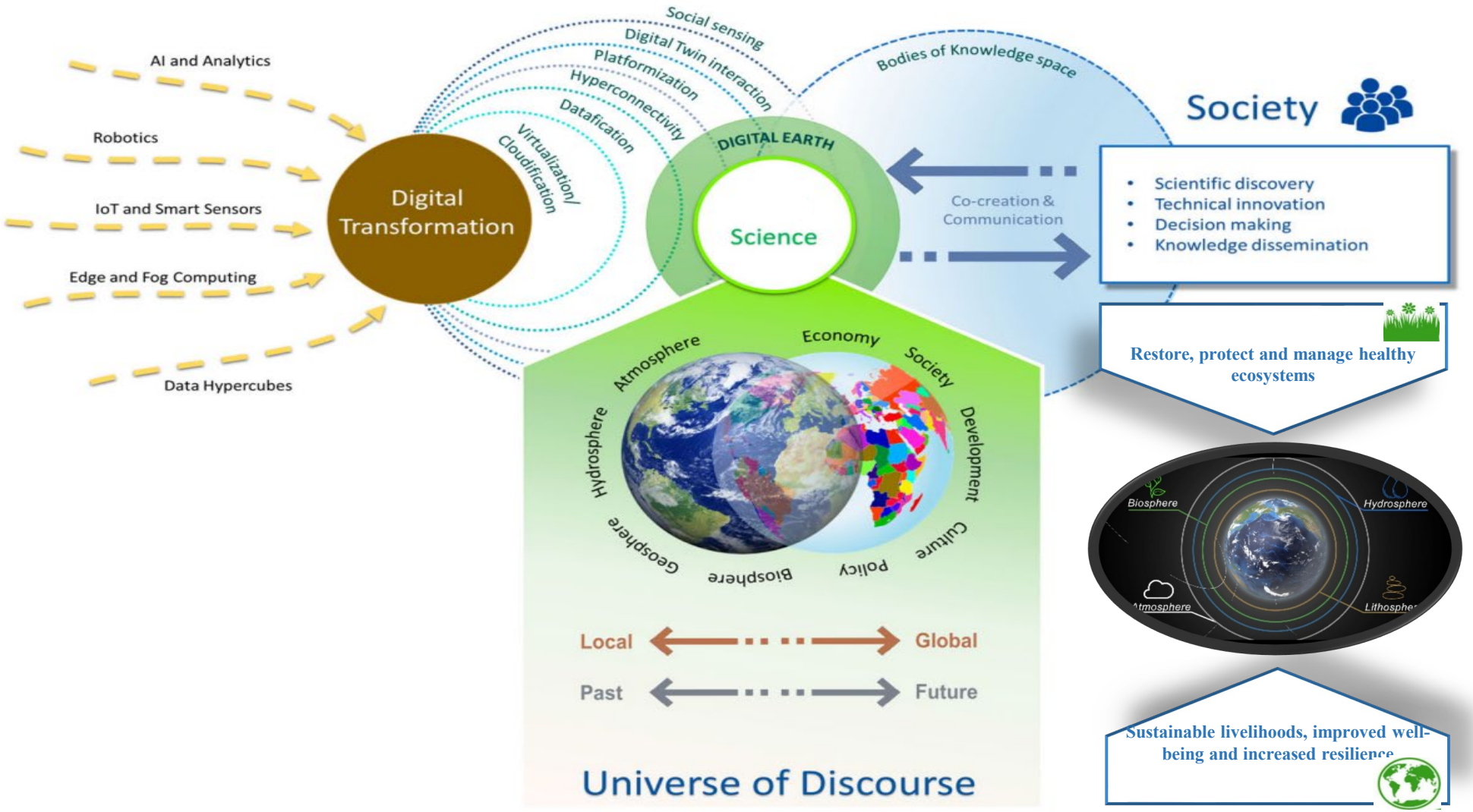








Post-2020 towards sustainable and resilient societies

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