TPE THIRD POLE ENVIRONMENT

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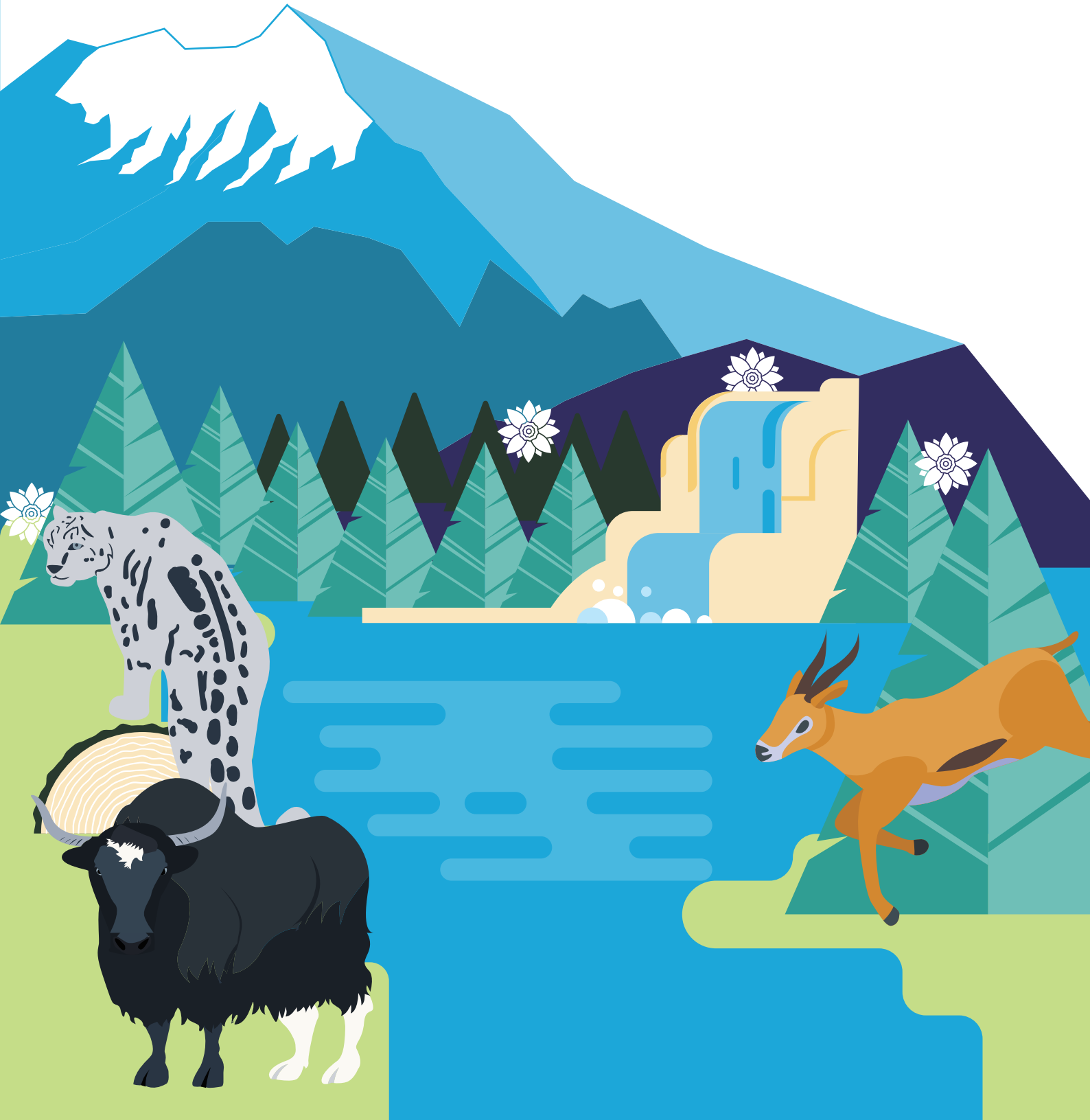
A Scientific Assessment of the Third Pole Environment

Executive summary



Executive summary

The Third Pole (TP), the Asian Water Tower and largest alpine ecosystems in the world, with an average elevation of 4,000 metres, encompasses the Tibetan Plateau and surrounding areas of the Pamir-Hindu Kush mountain ranges in the west, the Hengduan Mountains in the east, the Tienshan and Qilian Mountain in the north and the Himalayas in the south. With an area of more than five million square kilometres, the region is the largest storehouse of snow and ice outside the Arctic and Antarctica with about 100,000 square kilometres of glaciers in area. As the highest ecosystem in the world with 14 highest mountain peaks, the region provides freshwater to more than 12,000 lakes and more than 10 river systems. With vast coverage, varied and complex ecosystems, the TP is significant in terms of climate regulation, hydrological cycle, and environmental processes. Apart from being the most important Asian 'water tower', hosting globally important alpine ecosystems and biodiversity, the TP is equally significant as home to a diverse community.

The fragile highland ecosystem of TP is witnessing a higher rate of warming than the global average, resulting in faster glacier melt and increased frequency of ice collapse and glacial lake outburst floods. This environmental change is directly impacting the stability of the Asian water towers, thus threatening the ecosystem, biodiversity, and livelihood of people. Better understanding of the science behind the warming climate and its impact on ecosystem, biodiversity and livelihood is necessary for informed mitigation and adaptation policies for regional sustainability.

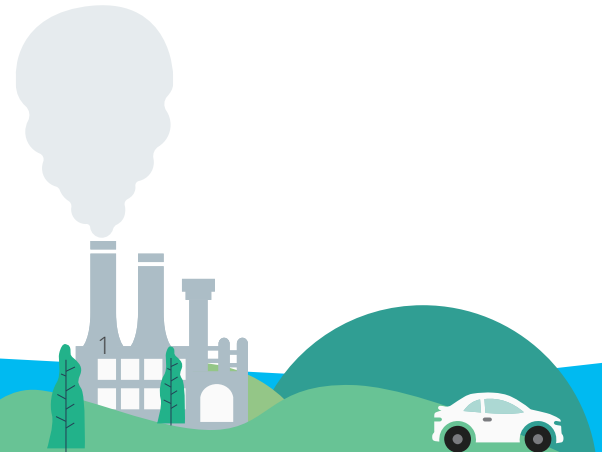
Considering the complex interactions of climatic and biophysical environment in the TP, an interdisciplinary approach is needed to address many challenges. Similar to the good examples set by the Intergovernmental Panel on Climate Change (IPCC) and Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), the present report is the first comprehensive assessment of environmental changes over the TP that outlines the collective understanding from interdisciplinary research on four key areas: climate, water bodies, ecosystems and human impacts, covering respectively facts and impacts of: climate change, water availability, ecosystem change and human influences on the environment.

Ice core and tree ring data show that the climate of the TP has experienced several warm and cold phases, with a general warming and wetting trend over the past 2000 years. Current warming started in the late 19th century but accelerated in the 20th century, with this century becoming the warmest in the past 2000 years. Similar to the warming trend, the recent episodes of precipitation increase began in the 20th century and continues. Both the warming and wetting trends are confirmed by the observational data in the TP in the past decades, which highlight seasonal and regional differences, amplified warming in higher elevations, and increased amounts during extreme precipitation events.

The consequences of variations in temperature and precipitation are visible as glacier area and mass have decreased in past decades, with more loss along the Himalayas and less mass loss in the more continental interior TP. Such variations have also resulted in an increase of natural hazards largely associated with cryosphere in recent years and there are indications of an increase in risks that might be associated with the changing climate in the future.

Snow cover depth, area and duration have decreased in recent decades. River discharge has also shown an increasing trend in most of the TP Rivers over the past decades. The variations in discharge are closely linked to changes in precipitation and glacial melt runoff contributions.

The TP is characterized by diverse ecosystems largely dominated by grassland, shrubland and the steppes, followed by forests, farmland, and wetlands. Forest area, which covered 11.5 per cent in 2005, has seen a change from primary forests to secondary types. Farmland is mainly in the Lhasa and Nianchu River basins with one cropping season. Forests and wetlands harbor immense terrestrial and aquatic biodiversity and provide an array of ecosystem services. The ecosystems over the TP have been changing, with earlier starts to the growing season, the expansion of vegetation coverage and an increase in ecosystem productivity. The increase in the vegetation coverage is strengthening the water-holding capacity of soil, which used to experience active layer thickening and permafrost warming throughout the TP, while also expanding desertification in the head water regions. The overall worsening trend of soil quality and water loss improved slightly after the 2000s.



The human activities outside the TP, including air pollutant emissions such as those of black carbon, heavy metal, and persistent organic pollutants, are negatively affecting the TP environment. It has been observed that the Indian summer monsoon, westerlies and local circulation such as those of mountain valley winds are responsible for bringing such pollutants into the TP region from different source regions. While the current levels of atmospheric pollutants such as black carbon, heavy metals and persistent organic pollutants are low compared with urban environments, they are showing an increasing trend. The input of atmospheric pollutants from surrounding countries to the TP not only has a negative impact on human health, but also contributes to the glacier melt.

The TP is one of the most biologically diverse regions in the world and is well known for its rare and endangered flora and fauna. While biodiversity at the global level is being challenged with higher threats and even extinction rate by about 20 per cent , the rate in TP is about 9 per cent for vertebrates and 5 per cent for plants. There has been a positive trend in species with increasing populations such as Przewalski's gazelle and the Tibetan wild ass, largely with conservation efforts in the TP countries. There is a need to survey biodiversity and collect biodiversity baseline data, enlarge cross-border conservation efforts, increase general community protection awareness, further improve monitoring and management, strengthen law enforcement, advance the effectiveness and pertinence of protection actions, build an alarm system to alert against introduced species, and relieve ecological impacts of climate change.

Air temperature in the TP is projected to increase in the late 21st century by 1.4-5.6°C relative to the 1995–2014 reference period. The elevation dependent warming by 1.8 ± 0.4°C is projected to continue into the future with the global warming scenario of 1.5°C by the end of the century. Similarly, precipitation is expected to increase by 6-15 per cent by the end of the 21st century but with regional and seasonal variations. Greater precipitation increases are projected for the westerlies dominated areas during the winter and monsoon dominated areas in summer.

Projections show the potential for significant consequences caused by a warmer and wetter climate in the future. Glaciers are expected to rapidly decrease in mass in the coming century, with two thirds of the present mass gone by 2100 in the southeast TP. Similarly, substantial decreases in snow cover are expected in the coming century and significant changes in the seasonality of river discharge. Total runoff in the TP Rivers is projected to increase, with the magnitude of runoff larger in monsoon dominated river basins than in westerlies dominated basins. This difference is largely due to the changes in runoff from precipitation increase in monsoon region compared with melt-dominated westerly region. In glacier-fed river basins, the future runoff will typically rise until a maximum is reached, before steadily declining thereafter because warming-induced glacier shrinkage can no longer sufficiently support rising meltwater. The timing of this turning point depends upon regional variation, warming rates and glacier storage and can vary among river basins.

The cascading effect of such projected changes in temperature and precipitation are significantly impacting cryosphere and hydrosphere, which will further affect ecosystems and biodiversity. The increase in temperature and precipitation is increasing the photosynthesis and the Net Primary Productivity (NPP). However, the projected NPP will vary regionally, decreasing from east to west. The vegetation growth and dominant species transition-induced "greening" also have positive feedback due to albedo and radiation.

Vegetation distribution will move up to the higher elevation. Ecological models project that such trends would significantly increase the extinction risk of narrow range species and other species in climate sensitive areas such as toad-headed lizard (*Phrynocephalus*). Conservation efforts are therefore needed along with evidence-based management options.

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