Tomsk State University Journal of Biology. 2012. № 1 (17). P. 142–147

ЭКОЛОГИЯ И ПРИРОДОПОЛЬЗОВАНИЕ

УДК 574

Terry V. Callaghan

Universities of Sheffield (UK),
Universities of Lund (Sweden),
Tomsk State University (Tomsk, Russia)

THE ARCTIC: AN INDICATOR OF THE PLANET'S HEALTH

The Arctic is a critically important component of the earth system and the Arctic is subject to dramatic change due to global warming in particular. To build capacity for better environmental monitoring and research in the Arctic, the EU has funded the SCANNET-INTERACT Consortium, which consists of partners from all the Arctic countries and 33 research infrastructures located throughout the large environmental envelope of the Arctic and a further 8 research facilities have joined as "observers", including 2 Russian infrastructures. But more infrastructures are required for long-term monitoring and research and these should be strategically located.

Key words: *Arctic; global warming; climate; SCANNET-INTERACT.*

Introduction

The Arctic is a critically important component of the earth system, affecting the energy balance, atmospheric and ocean circulation, freshwater storage, sea level, the storage and release of large quantities of greenhouse gases, economy, infrastructure, health, and indigenous and non-indigenous livelihoods, culture and identity [1]. Currently, the Arctic is subject to dramatic change due to global warming in particular and to other drivers of change such as globalization and trans-boundary contaminants. The need to document, understand, project and respond to changes in the cryosphere and their consequences has stimulated comprehensive international assessments.

In 2005, the Arctic Climate Impact Assessment [2] raised global awareness to the likely adverse consequences of climate change and its impacts in the Arctic while some beneficial effects were also described. The essential conclusions of this most detailed and comprehensive regional climate change assessment were summarized in the Polar Chapter of the Intergovernmental Panel on Climate Change 4th Assessment [3]. In the period following the publication of the ACIA report, new data showed that some components of the cryosphere were changing faster than had been modeled. These surprises included a record low extent of Arctic sea ice in September 2007 and faster loss of mass balance of the Greenland Ice Sheet than had been anticipated. For these reasons, the Arctic Council called for a new assessment focusing on the Arctic cryosphere in particular. This assessment, "SWIPA": Snow, Water, Ice, Permafrost in the Arctic is due to be published in November/December 2011[4]. Some of the extensive key SWIPA chapters have been summarized and made more widely available to a global audience with multi-disciplinary interests in a Special Report of Ambio [5]. In addition to the new assessment of environmental change in the Arctic, there has been an intense period of data accumulation resulting from activities within the International Polar Year of 2007/8 [6]. One of these projects "Back to the Future" focused on multi-decadal changes in the Arctic's environment [7].

Changes in the Arctic's environment

Together, the new research and assessment present a picture of change in the Arctic that has not been seen for 2 000 years, although there is considerable variability from region to region. Climate warming in the Arctic has increased at approximately double the rate as global climate warming and palaeorecords suggest that summer temperatures are now higher than during the past 2 000 years. Precipitation patterns have also changed. In general, projections include an increase in Arctic autumn and winter surface air temperatures of 3 to 6°C by 2080, an ocean nearly free of sea ice in September by 2050, and a general increase in precipitation. Snow water equivalent and snow-cover duration have generally decreased, particularly in maritime areas and in the North American sector. Although snow depths are increasing in many regions of Eurasia, warming and more frequent winter thaws are contributing to changes in snow-pack structure with more ice layers that affect food availability to many animal species including semi-domesticated reindeer.

Ice on land is also generally responding to climate warming. Permafrost temperatures and active layer thickness have generally increased throughout the Arctic although there is considerable regional variability. There has also been a recent loss of permafrost from several lower latitude sites formerly characterized by discontinuous permafrost. Projections indicate that by 2100 there will be widespread permafrost degradation throughout much of the Arctic with multiple consequences (e.g. ground slumping, drying of wetland habitats in some areas and pond formation in others, increases in methane emissions and damaged infrastructure, particularly along some coastlines). The Greenland Ice Sheet and Arctic glaciers and ice sheets in general are losing mass and contributing to sea level rise that is greater than previously estimated. Furthermore, the timing of ice formation and melt on Arctic rivers and lakes is changing with a net reduction in the duration of ice cover. Some lakes have completely disappeared; others are drying while still other areas contain newly-formed lakes.

These changes in the Arctic's physical environment have important consequences for feedbacks to the climate system that will affect the Arctic and other regions. Examples of feedbacks that will amplify future warming include reduced albedo and increased methane emissions. The changes in the physical environment also affect ecosystem services, both provisioning services (e.g. food resources) and regulatory services (e.g. greenhouse gas fluxes) [8]. Some habitats and their associated ecosystems are expanding while others are contracting rapidly. Cold-adapted biota are particularly at risk, while less specialized groups including invasive species from the south are likely to become increasingly common in the future. Extreme events such as thawing in mid-winter, tundra fires and insect-pest outbreaks are likely to become more frequent and may result in step changes in plant and animal community structure. All of these climate-related effects are compounded by rapid socio-economic development in the North, creating additional challenges for ecosystem management and for sustaining the traditional lifestyles of northern communities that depend on Arctic ecosystem provisioning services

Consequences for people in the Arctic and beyond

Changes in the Arctic's environment will affect economies, infrastructure, health, and indigenous and non-indigenous livelihoods, culture and identity as well as the lives of millions who live outside the Arctic. Feedback mechanisms between the Arctic's surface and the climate system will contribute to enhance warming while the Arctic's land-based ice is increasingly contributing to global sea level rise. Changes in permafrost and particularly the active layer will have important consequences for infrastructure with increased cost implications for building and maintenance. Ecological responses to changes in the Arctic's climate and cryosphere are likely to be complex and sometimes counter-intuitive: the "greening of the Arctic" [9] is not occurring everywhere. For example, increased temperatures and reduced snow-fall can cause summer drought and damage tree-line forests. However, Arctic residents are resilient and highly adaptive, even if the rate and magnitude of change will stretch their current adaptive capacity to both challenges and opportunities.

Priority needs

The rapid rates of environmental change in the Arctic, the possible step changes and the importance of the consequences for people, require greatly improved powers of observation, better predictive capacity and improved communication between researchers and stakeholders to facilitate the development of adaptation strategies. However, the Arctic is vast – the Russian Arctic stretches for over 140 degrees of latitude – and the population is sparse. Consequently, our observational capacity is low. Loss of research stations and observatories together with change from manual to automatic observing systems has further reduced the observational capacity for Arctic environmental change at a time when it is most needed. To build capacity for better environmental monitoring and research in the Arctic, the EU has funded the SCANNET-INTERACT Consortium (www.EU-INTERACT.org). This consists of partners from all the Arctic countries and

33 research infrastructures located throughout the large environmental envelope of the Arctic – from high Arctic polar deserts to north-temperate montane areas. In addition, a further 8 research facilities have joined as "observers", including 2 Russian infrastructures and the number of participants is steadily growing.

The SCANNET-INTERACT Consortium is multi-disciplinary. The research infrastructures support monitoring, research and education (depending on their location) on glaciology, permafrost, climate, ecology, biogeochemical cycling, and land use. Together, the stations host thousands of scientists from around the world and provide ground validation for remote sensing and computer models. They also provide nodes for single-discipline networks such as those monitoring permafrost and the active layer (International Permafrost Association activities – e.g. IPA CALM), ecological change (International Tundra Experiment – ITEX, International Long Term Ecological Research – ILTER), carbon fluxes (Integrated Carbon Observing Network – ICOS) and climate (WMO) while many more international programmes are in the process of linking to SCANNET-INTERACT.

Although 5 Russian infrastructures are partners in SCANNET-INTERACT and a further 2 have observer status, this is a very small sample basis for strategically sampling the vast environmental envelope of the Arctic. More infrastructures are required for long-term monitoring and research and these should be strategically located, for example where the region is likely to be particularly vulnerable to climate change and where a particular set of environmental interactions are not currently represented in the SCANNET-INTERACT network. The Yamal Region is such an example: the great economic importance of the region compared with its sensitivity to climate warming through permafrost dynamics and the interactions between extractive industry and Indigenous People's livelihoods require the establishment of a research station that can inform all the stakeholders about possible environmental futures for the region. Nesting this within the SCANNET-INTERACT Consortium would enrich with knowledge and technique any new research station and the whole Consortium. Whereas a new research station would play an increasingly important role in advising its local stakeholders, its contributions to many international networks through the SCANNET-INTERACT Consortium would add to a circum-polar "health-check" for the planet.

Acknowledgements

I wish to thank the Organisers of the meeting "The Yamal Innovation Forum-Innovations for humans and nature", Novyi Urengoi, 23–24 November 2011 for inviting me to the meeting and for hosting me. My participation was kindly facilitated by Prof. Sergey Kirpotin of Tomsk State University. In this short communication, I could not cite all the authors whose work I have described. However, details of specific papers can be located within the general publications cited here.

References

Olsen M.S., Callaghan T.V., Reist J.D., Reiersen L.O. et al. The changing arctic cryosphere and likely consequences: an overview // Callaghan T.V., Johansson M., Prowse T.D. (Guest editors). The Changing Arctic Cryosphere and likely Consequences. Ambio 40. In press.

ACIA. 2005. Arctic Climate Impact Assessment. Cambridge University Press, 1042 p.

Anisimov O.A., Vaughan D.G., Callaghan T.V. et al. Polar regions (Arctic and Antarctic) // Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change / Eds. by M.L. Parry, O.F. Canziani, J.P. Palutikof, C.E. Hanson, P.J. van der Linden. Cambridge : Cambridge University Press, 2007. P. 655–685.

AMAP. 2011. Snow, Water, Ice and Permafrost in the Arctic (SWIPA) 2011. Arctic. Monitoring and Assessment Programme (AMAP), Oslo.

Callaghan T.V., Johansson M., Prowse T.D. In press Arctic Cryosphere – Changes and Effects (SWIPA). Ambio 40.

Krupnik I. et al. 2011. (eds) Understanding Earth's Polar Challenges: International Polar Year 2007–2008. University of the Arctic, Roveniemi, Finland: CCI Press (Printed Version), Edmonton, Alberta, Canada and ICSU/WMO Joint Committee for International Polar Year 2007–2008.

Callaghan T.V., C.E. Tweedie (eds) Multi-Decadal Changes in Tundra Environments and Ecosystems // The International Polar Year Back to the Future Project. 2011. Ambio 40(6). P. 555–716.

Chapin F.S., Berman M., Callaghan T.V. et al. (with contributions from T.R. Christensen, A. Godduhn, E.J. Murphy, D. Wall, C. Zöckler) Polar ecosystems // R. Hassan, R. Scholes and N. Ash (eds). Ecosystems and human well-being: current state and trends. Washington : Island Press, 2005. Vol. 1. P. 719–743.

Bhatt U.S., Walker D.A., Raynolds M.K. et al. Circumpolar Arctic tundra vegetation change is linked to sea ice decline // Earth Interactions. 2010. № 14(8). P. 1–20.

Received November 29, 2011

Вестник Томского государственного университета. Биология. 2012. № 1 (17). С. 142–147

УДК 574

Каллаган Т.В.

Университет Шеффилда, Великобритания
Университет Лунда, Швеция
Томский государственный университет, Томск, Россия

АРКТИКА: ИНДИКАТОР ЗДОРОВЬЯ ПЛАНЕТЫ

Арктика является важнейшим компонентом в экосистеме Земли, влияющим на её энергетический баланс, атмосферную и океаническую циркуляцию, запасы пресной воды, уровень моря, хранение и высвобождение большого количества парниковых газов, экономику, инфраструктуру, здоровье, культуру и идентичность, а также жизни миллионов людей. В настоящее время Арктика драматично изменяется из-за глобального потепления, кроме того, на нее оказывают влияние глобализация и трансграничное загрязнение. Механизм обратной связи между арктической поверхностью и климатической системой будет способ-

ствовать усилению эффекта потепления, в то время как наземный лед Арктики все больше способствует глобальному повышению уровня моря. Необходимо следить за всеми изменениями, происходящими в Арктике, документировать их, чтобы смоделировать изменения в криосфере и их последствия.

Температура вечной мерзлоты и толщина ее активного слоя, несмотря на некоторое различие по отдельным регионам, в целом увеличились по всей Арктике. По предварительным прогнозам к 2100 г. будет наблюдаться широкая деградация вечной мерзлоты по всей Арктике с многочисленными последствиями (например, оползание земли, осушение водно-болотных угодий в одних областях, заболачивание других, увеличение выбросов метана и разрушение инфраструктуры, особенно вдоль береговой линии). Гренландский материковый лед и арктические ледники теряют часть своей массы, что способствует большему повышению уровня моря, чем это указывалось в предварительных оценках. Более того, сроки образования и таяния льда на арктических реках и озерах меняются с уменьшением ледового покрова: некоторые озера полностью исчезли, другие высыхают, в то время как новые продолжают формироваться.

В целях улучшения экологического мониторинга и научных исследований в Арктике Евросоюз профинансировал консорциум СКАННЕТ-ИНТЕРАКТ (www.EU-INTERACT.org). Данный консорциум состоит из представителей всех арктических стран и 33 научно-исследовательских организаций, расположенных в крупных экологических районах Арктики: от высоких арктических полярных пустынь до умеренных северо-горных районов. Кроме того, еще 8 научно-исследовательских учреждений присоединились в качестве «наблюдателей», в том числе два представителя из России; число участников данного консорциума неуклонно растет. Несмотря на это, необходимо увеличение количества стратегически расположенных участников, осуществляющих долгосрочный мониторинг климатических изменений (например, если регион особенно уязвим к изменению климата, но не представлен в сети СКАННЕТ-ИНТЕРАКТ).

Ярким примером является Ямальский регион: экономическая значимость региона в сочетании с его чувствительностью к глобальному потеплению, проявляющаяся через динамику вечной мерзлоты, и взаимодействие между добывающей промышленностью и средствами существования коренных народов требует наличия исследовательской станции, которая может информировать всех заинтересованных лиц о возможном экологическом будущем региона. В то время как новая научно-исследовательская станция будет играть всё более важную роль в консультации местных заинтересованных сторон, получаемые с ее помощью данные, добавляемые в международные сети через консорциум СКАННЕТ-ИНТЕРАКТ, позволят полнее представить приполярную «проверку здоровья» планеты.

Ключевые слова: *Арктика; глобальное потепление; климат; СКАННЕТ-ИНТЕРАКТ.*

Поступила в редакцию 29.11.2011 г.