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Adaptation and Change with Global Warming

The Emerging Spatial World-Structure and Transportation Impacts

Trausti Valsson and Guðmundur Freyr Úlfarson

Introduction

Today the governing spatial structure of Earth is that of a ribbon around the globe. Economic activity and habitation is mostly limited to this developed ribbon. As the Polar ice retreats and better ships and remote sensing are being developed, the habitable edge of the world is moving ever further into the Arctic, leading to the emergence of a new spatial structure of Earth: the semi-globe. In a semi-globe system, the Arctic is no longer the most remote area of Earth but its center.

The practical consequences of Polar ice retreat are notably Arctic resource development and Arctic shipping routes. The largest impact on global marine transportation occurs as all-year shipping develops in the Arctic, eventually leading to—because of shorter distances—most marine transport between the North Atlantic and the North Pacific going through the Arctic Ocean. This has important consequences for transportation, security, and natural resource use.

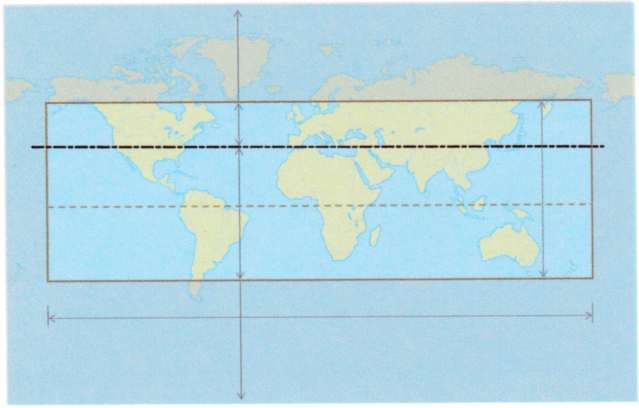

Figure 1 The Earth's ribbon of major habitation

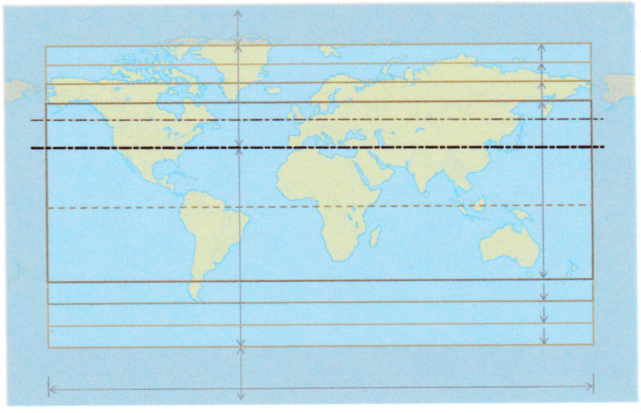

Figure 2 The expanding ribbon of major habitation with global warming

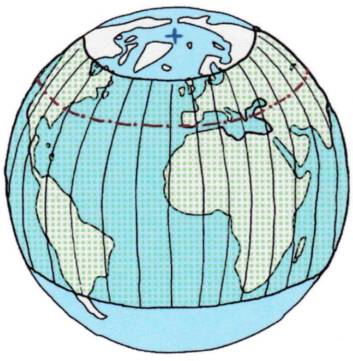

Figure 3 The world system of the ribbon

Development Toward a Semi-Globe

The effects of global warming and there by the melting ice combined with technical improvements in navigation and remote sensing could push settlements further north. The new world image would be a semi-globe rather than a ribbon.

Figure 4 The world system of the semi-globe

Figure 5 Potential Arctic shipping routes and possible transshipment harbors in the Aleutians and in Iceland

New Shipping Routes

As most of the Polar ice is predicted to disappear in the summer around 2040. The Arctic Ocean will provide access to the huge resources of the Arctic rim, with ships sailing to coastal ports and, via ice-free rivers, into the vast spaces of Siberia, northern Canada, and Alaska. The Arctic shipping routes have the advantage over the Suez and Panama canals that there are no size or capacity limitations. The opening of shipping routes through the Arctic Ocean facilitates the formation of new global shipping circles around North America and Eurasia. This might have a major impact on the global balance of power.

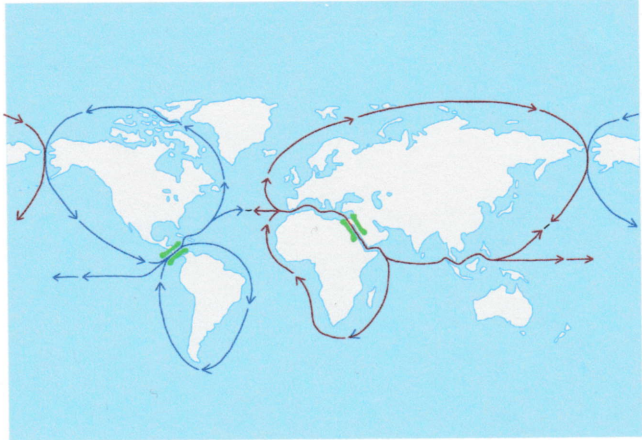

Figure 6 New major circles of international shipping between the Atlantic and the Pacific around North America and Eurasia with an ice free Arctic

Based on:

T. Valsson, G. F. Ulfarsson, 2009: Adaptation and change with global warming: The emerging spatial world-structure and transportation impacts. Transportation Research Record: Journal of the Transportation Research Board, No. 2139, National Research Council, Washington, D.C., U.S.A., pp. 117–124. DOI: 10.3141/2139-14.

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Megapatterns of Global Settlement

Typology and Drivers in a Warming World

Trausti Valsson and Guðmundur Freyr Úlfarsson

Introduction

Changes in settlement structures of the world can be described with ten spatial megapatterns

The drivers of the megapatterns are three:

1) **Global warming**
2) **Improved technology and resources**
3) **Important spatial positions**

Three of the ten megapatterns are described below:

Megapattern 1: ***Towards the Poles***	***Forces that pull:***	***Forces that push:***
	**Increased pull of the Polar areas because of the huge resources and improved transportation on land and sea because of less snow and ice**	**Push away from the central areas of the globe because of heat, lack of water, crowdedness, reduction of resources, pollution and conflicts**

Megapattern 1: Towards the Poles... driven by global warming etc.

Megapattern 4: ***To central areas in cold but warming regions***	***Forces that pull:***	***Forces that push:***
	**Cool, high interiors of very warm countries will be more comfortable than the coasts in these countries. Thus these interiors will develop increased draw**	**Migration to interiors of very hot regions will be helped by crowdedness, dwindling resources, pollution, and conflicts at coasts**

Megapattern 4: To central areas in cold but warming regions
... driven by improved global warming etc.

Megapattern 10: ***In the direction of the centre of land mass of Earth***	***Forces that pull:***	***Forces that push:***
	**The centre of the landmass of the globe—in the Urals—will draw people and activity from all directions, mostly in the northern hemisphere, with more open borders and activity**	**The wish to be located centrally—and not in remote areas—pushes people and activity towards central landmass areas**

Megapattern 10: In the direction of the centre of land mass of Earth
... driven by an important spatial position

Conclusions

The ten global megapatterns show that it is primarily the northern part of the northern hemisphere and the far North that will be the net recipients of settlement and activities. This will mostly be seen as increased shipping and increased resource exploitation.The likelihood of greatly reduced sea ice in the Arctic Ocean is here the largest factor. The increase in Arctic oil and gas activity will be great, mostly because about 22% of the oil and gas reserves of the world are estimated to be in the Arctic.

Based on:

- T. Valsson, G. F. Ulfarsson, 2012: Megapatterns of global settlement: Typology and drivers in a warming world. Futures, 44(1):91–104. DOI: 10.1016/j.futures.2011.09.001.
- Trausti Valsson og Guðmundur Freyr Úlfarsson, 2012: Kortlagning tilfærslukrafta í mótun byggðamynsturs hlýnandi jarðar. ...upp í vindinn, tímarit umhverfis- og byggingarverkfræðinema við Háskóla Íslands, 31:44–48.

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Future Changes in Activity Structures of the Globe

under a Receding Arctic Ice Scenario

Trausti Valsson and Guðmundur Freyr Úlfarsson

Introduction

Geospatial maps are here used for interpreting of what a scenario with a warming Arctic with less ice will mean for activity structures of the globe in the future. **This will enable certain locations in the High North to become important activity areas.**

Four factors were chosen and it *was estimated with overlay maps,* where they would have *a positive or a negative impact:*

1) ***Temperature and water**: Areas that were previously too cold become more accessible. Likewise areas that are already hot become even hotter*
2) ***Arctic Shipping**: Connecting Europe and Asia via the Arctic would change the current global image. That will increase the importance of the Arctic and reduce the importance of the areas surrounding the Suez- and Panama canals*
3) ***Arctic Oil**: It is estimated that up to 22% of the global undiscovered oil- and gas deposits are located in the Arctic, mainly in coastal areas. That will increase the importance of the Arctic and reduce the importance of e.g. the Middle East*
4) ***Polar center**: Today mankind lives on a ribbon surrounding the globe, meaning that the center of habitation is a linear one. The warming climate will push the center north and south and since the majority of earths landmass lies of the northern hemisphere, the importance that area would increase because it comes more central*

Figure 1 Coasts that will be most positively impacted economically by oil and world shipping in combination

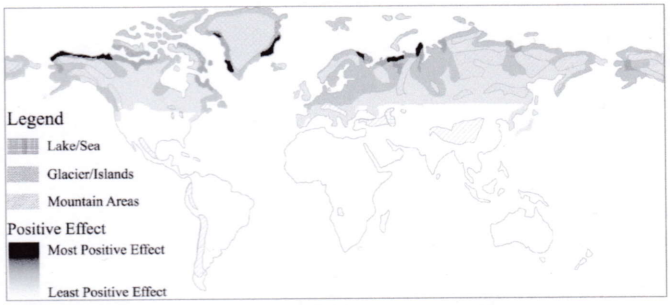

Figure 2 Net positive economic effect due to changes in temperature and water, shipping, oil, and Polar center under the receding Arctic ice scenario

Figure 3 Net negative effect due to Arctic shipping and a new Polar center

Figure 4 Net negative effect due to changes in temperature and water, shipping, oil, and Polar center under the receding Arctic ice scenario

Conclusions

What is most apparent from the evaluation maps and the overlay maps is that ***the High North is in some respects going to gain from global warming,*** but ***the central and southern areas of the globe will be negatively impacted in some ways.***

This is somewhat ironic because the northern and industrialized nations of the world, that have profited from the exploitation of oil, coal, and gas for up to 200 years, will be the ones that may see some gains from the greenhouse gas pollution and the warming that it causes.

The developing nations, that have just started to enjoy the benefits of relatively cheap oil, and are building up their wealth, ***will be most negatively impacted by global warming***. That the North may enjoy some benefits from global warming becomes apparent on the evaluation maps of this paper. The maps show that it is especially Alaska, N-Canada, Greenland, Scandinavia and Siberia that will reap benefits by global warming.

Even if ***the High North, and some of the coastal areas at the Arctic Ocean***, will enjoy economical benefits with global warming, they will also, on the other hand, ***be subject to great ecological threats*** due to the added activity and exploitation of their natural resources, notably due to accidental oil spills.

Based on:

T. Valsson, G. F. Ulfarsson, 2011: Future Changes in Activity Structures of the Globe under a Receding Arctic Ice Scenario. Futures, 43(4):450–459. DOI: 10.1016/j.futures.2010.12.002.

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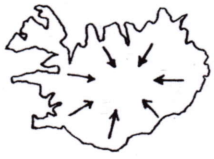
A Theory of the Evolution of Settlement Structures
Based on Identification and Use of Patterns:
Iceland as a Case Study

Trausti Valsson, Guðmundur Freyr Úlfarsson
and Sigurður M. Garðarsson

Introduction

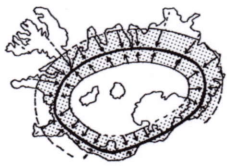
- ***The paper presents a theory of how settlement structures originate and evolve,*** based on identifying drivers of change and resulting spatial settlement patterns.
- ***Climate, resources and their access, and spatial position are the primary drivers for the patterns*** of how settlement structures will evolve.
- ***As changes occur in these conditions the settlement structures eventually change.***
- ***The method*** presented can be used to study ***how settlement structures may evolve in the future*** based on projections and predictions about changes in the drivers. The method is illustrated by using Iceland as a case study. *(Four out of eleven patterns are explained here)*

Patterns driven by a warming or cooling climate:	***Forces that pull:***	***Forces that push:***
 **By warming:** ***Towards the highlands of the interior***	A growing pull of the interior highlands in periods of warming. Less snow cover makes transport easier and thus makes land and resources more accessible. The vegetative cover increases, allowing more agriculture	A push away from the coasts because of the rise in the sea level, and increased coastal flooding because of stronger winds—all leading to increased coastal erosion. Also high land prices along some coasts push towards use of the interior
 **By cooling:** ***To coasts, away from the cooling highlands***	The ocean at coasts rarely gets below 0°C, even if air temperatures are very cold. The coasts in cold countries are thus warmed by the ocean in winters and pull people, especially in very cold periods	High lying central areas get very cold and are packed with snow in very cold periods. This leads to poor or no harvests, so farmers there are forced to relocate towards the warmer lowlands and coasts

From ***Table 1:*** *Patterns driven by climate change*

Patterns driven by improved technology and resources:	***Forces that pull:***	***Forces that push:***
 ***Along coasts because of sea transport***	The settlers of Iceland came with boats from Norway. They were at first gatherers and hunters and used their boats to traverse the coast to find good places. After this period "permanent" settlements with livestock developed	Changes in fish, bird, and seal seasons pushed the first settlers to change location on the coast. Sea ice and bad winters in the north and east had the same effect

From ***Table 2:*** *Patterns driven by improved technology and resources*

Patterns driven by an important spatial position:	***Forces that pull:***	***Forces that push:***
 ***Towards the linear centre of the Ring Road***	In 1974 a linear centre was created by the completion of the Ring Road. This has led to the development of a "ribbon of habitation" around Iceland, which draws people and activities from both directions	Placement far away from an active ribbon of habitation is unpopular for many people and activities, pushing them towards the Ring Road. Today Internet and other communication tools reduce the drawbacks of remote placements, which may temper this effect

From ***Table 3:*** *Patterns driven by an important spatial position*

Conclusions

- Global warming ***will induce a pull of settlements towards the warming highland plateau*** of the country because of less snow, better accessibility, and more vegetation. This will be helped by a push of settlements away from the coast towards the more elevated interior due to a rise in sea level.
- In Iceland, an opposite pattern—towards the coast—also applies because new ***transshipment harbours serving Arctic sea routes and oil resources will create a pull towards some parts of the coastline***

Based on:

Valsson, T., G. F. Ulfarsson, and S. M. Gardarsson, submitted: A study of the evolution of settlement structures—Identification and use of patterns for prediction. Under review for possible publication.