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# A theory of the evolution of settlement structures based on identification and use of patterns: Iceland as a case study

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ABSTRACT

This 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.

The results of the case study suggest that 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.



## 1. Introduction

The way settlements originate and evolve is of interest for academic disciplines such as geography, demography, economics, regional planning, and future studies, as well as for planning. Often the study of settlement formation starts as a general social history with emphasis on factors including who were the first settlers and what social systems they introduced. Some researchers of advanced settlements, like Mumford, concentrate on physical aspects like the creation of cities [1]. Jellicoe and Jellicoe [2] give a broader view, including not only the cities but also land management and landscape design. McHarg [3] describes how forms of early settlements grew out of nature-given conditions, comparable to the growth of the form of organisms and ecosystems.

Many theories on the forms of settlements deal with geometric characteristics. A famous example is Christaller's [4] theory, which is expressed as hexagonal shapes (crystals). Form as a foundation for settlement structure analysis is limited because the form is a visual, surface expression of influencing forces. As in Christaller's [4] case, other theories of geometric form are unable to provide a full explanation of what gives rise to a form or how that form occurs in the first place. This is because settlement forms are never static but rather ever-changing with time. Hence, knowledge of the underlying forces and conditions that shape the form or the structure helps enhance the understanding of settlement structures.

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As has been done in the search for a fundamental theory in the natural sciences, the study of dynamic settlement structures needs to be reduced to an axiomatic level. Lynch [5] attempts to create an overall theory on city and settlement form but states that, despite his work, a comprehensive theory on how settlement structures originate and evolve is missing; a recent review of Lynch's work expresses the view that such theory is still missing [6].

An attempt to create an overall theory was undertaken by Alexander et al. [7] in the book *A Pattern Language*, which is a collection of static patterns. In a recent interview, Alexander reflects on his theory: "As you probably know, when an organism is being built – obviously it's happening over the course of time. . .It has a lot to do with biology. I've never yet given a fully coherent account of how these generative sequences work. . .I feel now that that would have been a better approach. But I didn't know that at the time." [8].

A limitation of previous attempts at such an overall theory of settlement form or structure is the absence of the dimension of time. It is the inclusion of time which is the basis for the revolution induced by Darwin's [9] theory, where he demonstrated that the forms of nature are not static but are continuously evolving in accordance with changing conditions. This view has recently been put forth by Rammel et al. [10] who maintain that "sustainable development is an open evolutionary process" and by that rejects the notion of it being static.

Temporal aspects of settlement evolution have primarily been studied in light of human migration. One such theory is based on push and pull forces which drive migration away from some areas and towards others [11]. The forces that have been studied are primarily social forces, such as wealth and poverty. Recent studies have used the concept of push and pull forces to explore physical settlement structures on a global scale [12,13]. There the forces have been viewed as arising due to changes in climate, resources, technology, and settlement structures. That work starts by locating areas on maps that are best in terms of climate, resources, and spatial position. The resulting maps show the best comparable areas in the future and indicate the possible pattern, i.e. the direction of the evolution of the settlement structure [12,13]. These studies, however, were limited because the theoretical foundation was not developed and the link between the global scale and the country scale was not dealt with.

The present paper aims to contribute towards developing a theory to study settlement structures by working with patterns that evolve over time and thus never have a fixed form of expression. Climate, resources and their accessibility, and the influence of spatial position are the primary factors influencing the foundation of settlement structures and later settlement change. A multitude of other influences exist but in this paper the focus is on these primary influences and their impact. The presented method is used to make predictions of changes in future settlement structures in cold coastal countries which are induced by changes in climate, resources and their access, and spatial position, with Iceland as a case study.

## 2. Method

The theory put forth in this paper has some parallels to Darwin's [9] famed theory that the physiology and the forms of species have originated and evolved in accordance with environmental conditions, and that – as the conditions change – the organisms adapt to those changes. The present theory postulates that settlement structures in resource oriented and climate sensitive areas will also evolve under the influence of changes in these conditions.

Fig. 1 shows the conceptual framework for the theory. Initially there is (I) Amorphous space, which is a theoretical initial condition which is characterized by: (1) no variation in climate; (2) no variation in resources; and (3) no clusters of settlements.

This is followed by step (II) Differentiation, which is the creation of variations from the initial condition. *Resources* have come to be because "amorphous" material has been differentiated by the working of "engines of differentiation". This term is

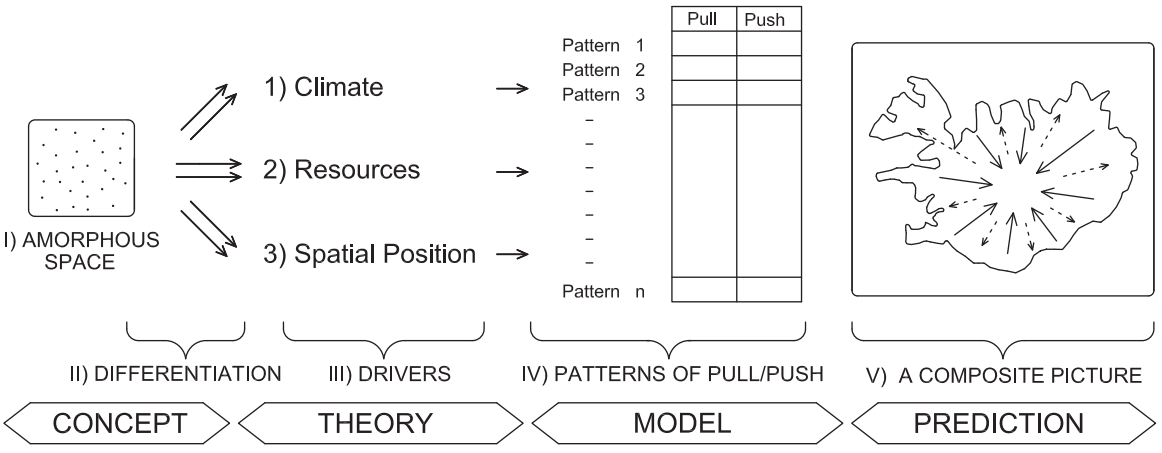


**Fig. 1.** The steps of a study of the evolution of settlement structures.