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Mapping social structures by formal non-linear information processing methods:

Case studies of Estonian islands environments

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Declaration:
Hereby I declare that this doctoral thesis, my original investigation and achievement, submitted for the doctoral degree at Tallinn University of Technology has not been submitted for any academic degree.

/*Karin Lindroos*/

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Sotsiaalsete struktuuride kaardistamine formaalsete mittelineaarsete infotöötluse meetoditega:

Juhtumiuuringud Eesti saarte keskkondades

TUT 2008

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Abstract

It is important to recognize the value of utilizing the novel non-linear information processing methodologies in seeking better understandings of the world and developing integrative, interdisciplinary, relatively large social and geographic research in response to priorities of science and society discovering new knowledge based on deep semantics.

Why do social structures exist? People organize themselves because they believe that it is the most efficient way to reach their goals. To be is to be in some kind of Place. Nothing we do is unplaced (Casey, 1997). Place identity is not an objective or natural ´given´, but something that is attributed to a place by people. The crisscrossing of social relations and socio-cultural significance, of broad historical shifts and the continually altering spatialities of the daily lives of individuals, make up something of what a place means - of how it is constructed as a place.

The mutual constructing of the identities of the people and identities of the places is a constant process. Buildings, therefore, are precipitates of social relations, which go on being changed by them and having a life within them. As Doreen Massey (2002) says, the ”architecture“ of the settlements is also the frame of social relations. The spaces of social relations are constructed, just as buildings are constructed; they can be adapted, as buildings can be adapted; they are not ”material“ as buildings are material, but they can be as hard to walk through as a wall“. This is an immaterial architecture: the architecture of social relations. And yet, social relations are practiced, and practices are embodied, they are material (physical). Places are the product of material practices.

In this PhD thesis I am following up the idea of the hidden social relationship in everyday-life environments, which is one of the significant factors to create place identity. Community development occurs as an interaction of human agency and a social system. Human activity in general is constructed in social structures. The structures both enable and restrain individuals' activity. The structures are instruments of social practices, rules and resources (Giddens 1984). At the end of 1980, a broader discussion was raised again about the concepts and psychology of the place, locality and nativity (behavior places) (Kaplan, 1991).

This study focuses on observations of Estonian islands as target cases. The structure of social relations (including family and friendship) encountered on small territories raised a question of how to disclose and map this invisible or hidden structure. We had to find methods for information processing which lack their own internal semantics and can be used to measure commensurate nominal features and to identify nonlinear relations of multidimensional data. However, information processing methods for non-metric no-yes type data, or formal processing systems turned out most suitable.

The author had a good opportunity to test the Conformity Scale and Monotone Systems techniques (the plus/minus techniques) worked out by L. Võhandu and J. Mullat (1976) at Tallinn University of Technology, Estonia,

As the Conformity Scale and Monotone Systems identify the cores of elements or attributes and form ontological frameworks, we decided to additionally test also the Formal Concept Analysis (FCA) developed by German researchers Wille, Ganter and Stumme (1992, 2005), which is used increasingly in the world and which, according to its name, divides attributes and elements into respective concepts.

Large amounts of variables from different categories make use of standard statistical methods in spatial, economic and social research extremely difficult. Monotone methods and Formal Concept Analysis (FCA) develop and distribute, its novel visual analysis platform for data mining, which analyzes multi-dimensional data and predicts the social behavior (predictive non-linear analytics) by identifying significant semantics, high-level concepts and potential new kernels, software excels particularly by its unique visual approach to multi-dimensional data that allows even laymen to recognize relationships and to define settlement groups. Our methods that require only a discrete data table are based on a computationally simple weight functions that describe objects "typicality" for the data table.

This thesis proposes an interesting method for knowledge discovery and rediscovering in geography that combines the elements from the Formal Concept Analysis and from the theory of Monotone Systems, which will enable us to disclose the hidden and imperceptible structures of natural and social world.

In addition, my research task is to disclose the hidden invisible reality in order to identify societal structures and actors and to find out what their effect on development of places is.

Key words: social structures, social network analysis, information visualization, data mining and knowledge discovery, conformity scale, non-linear information processing, monotone systems, deep semantics, ontology, behavior places, conceptual structures, formal concept analysis.

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1. Introduction

It is important to recognize the value of utilizing the novel non-linear information processing methodologies in seeking better understandings of the world and developing integrative, interdisciplinary, relatively large social and geographic research in response to priorities of science and society discovering new knowledge based on deep semantics.

Human activity in general is constructed and organized in social structures. The structures both enable and restrain individuals' activity. The structures are instruments of social practices, rules and resources.

As my studies focus on Estonian islands environment, the structure of social relations was revealed in particular on such small territories, and the question was raised of how to disclose the hidden invisible reality in order to identify societal structures and actors and to find out what their effect on the development of the places is.

First, a search for methods of information processing which lack their own internal semantics was made to be used for the measurement of commensurate nominal features and identification of non-linear relations of multidimensional data.

However, information processing methods for non-metric no-yes type data, or formal processing systems are most suitable. I had a good opportunity to test the Conformity Scale (CS) and the Monotone Systems (MTS) techniques (the Plus/Minus Techniques) worked out by L. Võhandu and J. Mullat at Tallinn University of Technology, Estonia, reported in their article covering the Formal Concept Analysis (FCA).

The new formal information processing methods used will enable us to disclose the hidden and imperceptible structures of natural and social world. In addition, in the scientific discussion concentrating on the concepts and psychology of the place, locality and nativity (behavior places) from the 1960s Lynch (1960) and Barker´s (1968) famous theoretical conceptions are revisited.

Focus in my thesis is on geography although it concerns other social sciences (sociology, psychology) and uses non-linear methods of formal information processing.

Geography itself is featured by a renaissance during the past decade. Geography´s focus on human society and the environment through the perspectives of place, space, and scale is finding increased relevance in the fields ranging from ecology to economics. At the same

time, many of its research tools and non-linear analytical methods have moved from the research laboratory into mainstream of science, that process being called rediscovering geography.

This is the most essential motivation and purpose that has driven efforts to propose new powerful information processing systems to the geography.

1.1 Introduction to conceptions of geographical behavior of places

To be is to be in some kind of Place. Nothing we do is unplaced (Casey, 1997)**.**

People´s relationship to the places[1], and places and people to one another have changed, adjusted, readjusted over time. That shifting, complex, micro-spatiality of individual yet interconnected lives is, moreover, set within a broader social history, which is also the history of making and remaking of social spaces. In less than hundred years our target places in Estonian islands have passed from aristocratic landownership, through municipal socialism, toward attempts at neo-liberal privatization. The breathing out and in of individual lives has been set in counterpoint with programs of social reconstruction that have made and remade this place on a wider social canvas.

The crisscrossing of social relations, of broad historical shifts and the continually altering spatialities of the daily lives of individuals, make up something of what a place means, of how it is constructed as a place. (Such a picture could be endlessly elaborated, and more complexities drawn out) (Massey, 2002).

The mutual constructing of the identities of the people and identities of places is a constant process. Buildings, therefore, as precipitates of social relations, go on being changed by them and having a life within them.

We cannot tear off people, not only from space but also from time where they are at the moment (Harvey, 1973). Each physical framework usually has its use story. Places cannot be regarded as isolated moments of time. Every site has a long history that bears on its present. Every site will have a long future, over which the designer and planner exerts only partial control. The new site form is one episode in a continuous interplay of space and people. Sooner or later, it will be succeeded by another cycle of adaption. (Lynch , Hack, 1994).

Some approaches assert that our physical setting determinates the quality of our lives. That view collapses under careful scrutiny, and then it is a natural reaction to say that the spatial

[1] In this study, the term ´place´ is a synonym to a settlement, or setting. A region or area can contain several places.

environment has no critical bearing on human satisfaction. Each extreme view rests on the fallacies of the other. Organism and environment interact, and environment is both social and physical. You cannot predict the happiness of anyone from the landscape he lives in (although you might predict his unhappiness), but neither can you predict what he will do or feel without knowing his landscape and what he has experienced. People and their habitat coexist. As humans multiply and their technology comes to dominate, the conscious organization of the land becomes more important to the quality of life. (Lynch , Hack, 1994). Well-organized, productive living-space is a resource for humanity, just as are energy, air, and water. (Lynch,Hack, 1994). Differences in environmental perception depend on factors such as age, gender, lifestyle, length of residence in an area, and physical, social and cultural environment in which a person lives and was raised. Despite everyone effectively living in their ´own world´. Similarities in socialization, past experience and the present environment mean that certain aspects of imagery will be held in common by a large group of people (Knox, Pinch, 2000).

Barker and its colleagues (1968) were determined by recording only overt behavior that in most of their research they failed to investigate the lewian life space [2] perspective into the behavior setting theory (Wicker 1987). Barker´s theory has been particularly significant for demonstrating how recurrent patterns of behavior have the effect of establishing "programs" for behavior within community settings. They have revealed that past actions of people become an important part of the structure of environments or of "settings" (Barker, 1968, Wicker 1987).

As society changes, so does signification. Meanings attached to the environment become modified as social values evolve as a response to changing patterns of socio-economic organization and lifestyles (Knox, 1984, 2000).

Relph (1976) argues that physical setting, activities, and meanings constitute the three basic elements of the identity of places. Place identity is not an objective or natural ´given´, but something that is attributed to a place by people.

According to Dutch geographers Paulus Huigen and Louise Meijering (2005) it is not always clear what exactly is meant by `place identity`. Sometimes it is described in terms of culture.

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[2] Kurt Lewin´s concept of human behavior based on the dynamic organization of behavior in his book "One Boy's Day" (1952). He developed a transactional theory that emphasizes that a person's behavior at any point in time is the result of the holistic organization of personal and environmental forces acting with ?a person's "life space."

Often, a place derives its identity from the landscape or built environment. A place has to have a “face” to succeed in marketing terms. Heritage may be the outstanding place characteristic, which is related to the face of place. The various approaches use the term ´place identity´ show that it is not a completely transparent concept.

This range of topics has been given some coherenece by two separate theoretical streams: the works of Roger Barker and of Kevin Lynch are the best characterized and summarized by the Dutch geographers Paulus Huigen and Louise Meijering (2005). For that reason the focus of this research is on the following Huigen´s and Meijering´s concepts:

I. Place identity as a social construct.
II. Place identity based on the characteristics of the place.
III. Place identity is to a large extent based on the past.
IV. Place identity is debatable.
V. Place identity is attributed within and characterized by a particular context.
VI. Place identity is that its identity attribution is a continuing process in which new actors establish themselves and goals and ideas change.

That conceptual framework coincides theoretically with my case studies in Hiiumaa and Saaremaa, a starting point of this research.

1.2 Introduction to formal methodology

In order to analyze places we took a number of different attributes including activity indicators and geodata from different categories, which are not comparable using traditional statistical methods: business and economic, intervals of economic indicators, growth/decline trends of indicators, intervals of demographic indicators, cultural and social indicators, territories and objects under nature protection, beaches, agricultural activity, service providers (including public sector), technical infrastructure such as airfields, ports, landing places etc. that can be characterised as indicators essential for human activity on a small territory.

Saaremaa and Hiiumaa are the islands of the Baltic Sea with territories of 2922 and 1049 km², with a population of 38,000 (Saaremaa) and 11,000 (Hiiumaa) inhabitants.

There are 488 and 185 settlements accordingly, with different sizes, degrees of importance and gravity. To describe the behavior places, 254 indicators are at our disposal.

In the space of human activity one factor is related to another. Indicators are not comparable to each other either and a relatively large amount of attributes makes it extremely difficult to use the standard statistical methods (like, e.g. regression analysis).
Moreover, the aim is to analyze and use multidimensional and qualitative indicators that cannot be measured with statistical analysis, and obtain adequate quantitatively expressible results, to support the survey of how the behavior places and social networks, in turn, are developing in an environment.

The availability of large quantities of data tends to mask a broader underlying problem: geographers must also improve the practice of relating the (”front-end” of geographic analysis – conceptualization and data selection/sampling and design with back-end modeling and analysis. It is important that the capacity of geographic analysis to address issues of complex systems and nonlinear dynamics needs to be improved in order to fulfil geography’s potential to contribute to the body of science.
In addition, it is important to recognize the value of utilizing a variety of methodologies in seeking better understandings of the world, combining geography’s characteristic appreciation of diversity with its recognition for producing knowledge.
Rediscovering geography also means to develop integrative, interdisciplinary, relatively large geographic research initiatives in response to priorities of science and society. The utilization of geography’s perspectives and knowledge base has increased immeasurably.
The research task is to disclose the hidden invisible reality in order to identify societal structures and actors and to find out what their effect on the development of places is. Scientific research of places will enable us to disclose the hidden and imperceptible structures of natural and social world. My purpose is to prove that.

My pursuit is to follow up an idea of a novel visual analysis platform, which analyzes multi-dimensional socio-spatial data and predicts the social behavior (predictive non-linear analytics) by identifying significant semantics, high-level concepts and potential new kernels, software excels particularly by its unique visual approach to multi-dimensional data that allows even laymen to recognize relationships and to define settlement groups (Mullat, 1976, Võhandu, 1989, 2003, Lindroos (Juurikas), Torim, Võhandu, 2006, 2007, Torim, Lindroos, 2008) in this thesis. As a result, **support to geographical and social research to understand and to predict the future human**

behavior in the observable area will be offered by novel multidimensional analysis methods.

In the Conformity Scale (CS) and Monotone Systems (MTS) it is not required to know the structure of social relations in advance – it will be found as a result of the analysis and mapping of behavior places and also so-called invisible space, or the part of space people often forget about because they do not use it. Hence, self-organisation of a system can be defined also with the help of new methods used in this thesis, to be examined next. In these terms, the birth of associations based on similarity (tractive force) as well as contrasting (repulsive force) of the elements and characteristics are significant.

1.3 Organization of the thesis

This subsection describes how the thesis is organized.
A schematic view and the structure of my interdisciplinary work are shown in Figure 1.
A review of the geographical theory is based on P.Huigen´s and L.Meijering´s behavior places conceptions is presented in Chapter 2.
Chapter 3 covers theoretical considerations of the basis and the conceptual framework.
New methodological approaches are presented in Chapter 4.
Chapter 5 is discusses the empirical case in the Estonian islands environment, attempts are made to classify villages based on their similarity and typicality among other settlements.
In subsection 5.1 a weight called conformity is search for each element (settlement) in a data table. Conformity for an element is calculated by a transformation where instead of the attributes value its frequency in the system (so-called frequency transformation) is used. Intuitively conformity describes objects "typicality" for the entire data table (system). In the same way the attributes of Saaremaa and Hiiumaa are analyzed in subsection 5.4.
As the Conformity Scale and Monotone Systems identify the cores of elements or attributes, and form ontological frameworks, additionally, the Formal Concept analysis (FCA) method developed by Germans Wille, Ganter and Stumme (1992, 1999, 2005) was analyzed, as it is used increasingly more widely in the world and which, according to its name, divides attributes and elements into respective concepts in subsection 5.2.
Organizational and hidden structures and nested hierarchy of the settlements will be improved by the use of the methods of Monotone Systems and the Management Functions distribution

matrices in subsection 5.3. Two different management functions based on Techniques of Minus and Plus were used.
Chapter 6 covers the discussion, which is the bridge between the theoretical conceptions, considerations and formal methodology proposing the results of our research.
Chapter 7 presents the conclusions of the thesis highlighting the contributions and directions for future research.

1.4 Research tasks

A starting point for this thesis is that the conceptual framework coincides theoretically with my case studies in Hiiumaa and Saaremaa and I will prove that there exist deep social structures and constructions.
Thus, my research task is to identify and map those hidden structures invisible to the eye.

We will find some advantages and promising results using the novel processing methods worked out in TUT bycomparing them with the standard statistical methods and FCA.
It is very important to consider the following:

- We do not have to know any relationships between the data in advance.
- Data will be totally separated (impossible to affect the results).
- We can and will use mixed-types and large amounts of data.

We expect to obtain the following results (Figure 1):

- new types of graphs which show the ontology;
- linkages between data;
- concepts classification;
- hierarchical classification (using the management functions);
- eventuality to discover development areas;
- context maps, disclosing hidden structures and deep semantics.

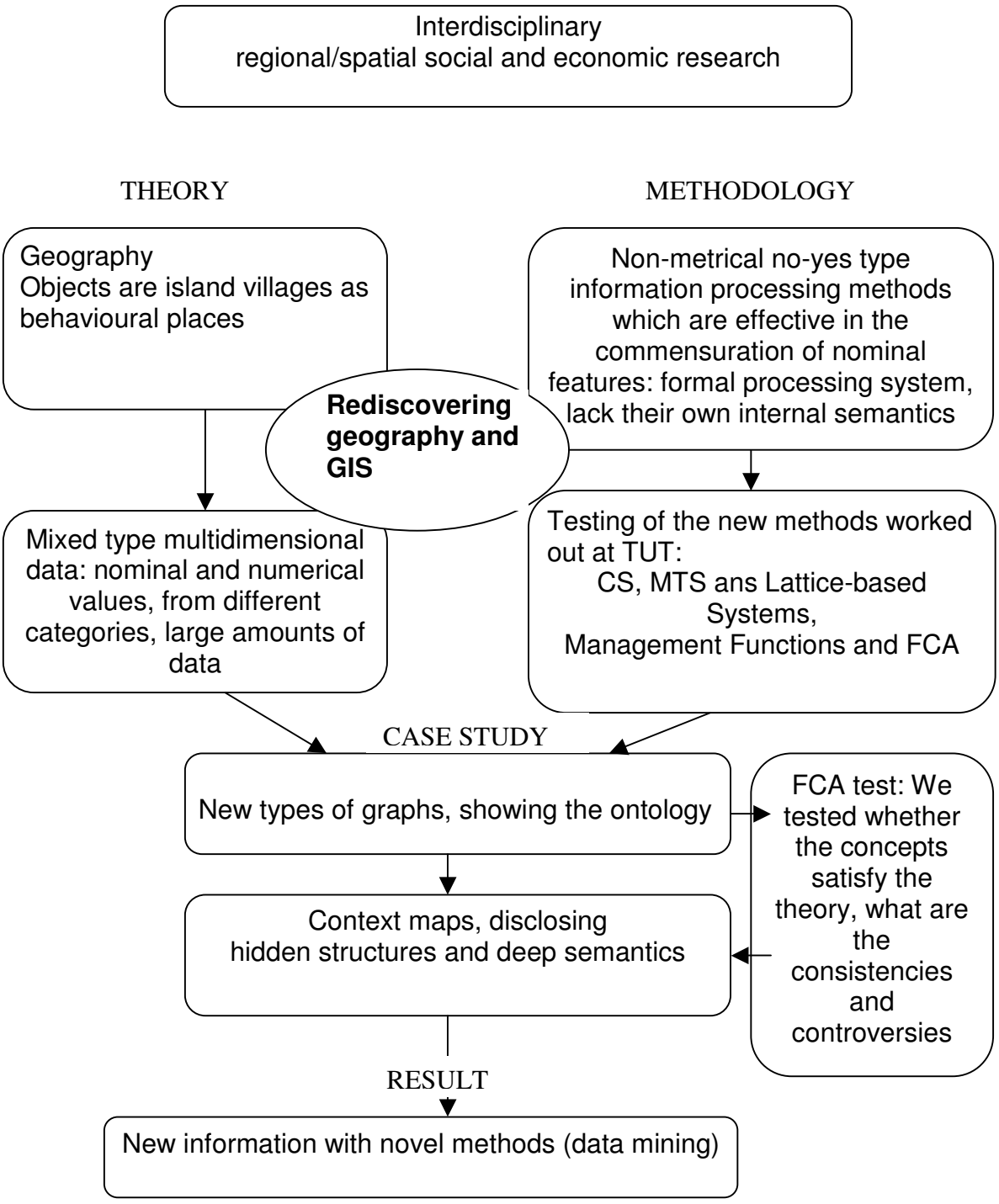


Figure 1. Structure of the interdiciplinary studies of the author.

1.5 Introduction to interdisciplinarity: Living systems

Borrowing the title of the Noble price laureate physicist Erwin Schrödringer´s work "What is Life?", our question is - what are Living Systems?

There is a limit to the inherent abilities and performances of human beings as living things. Human beings have learned to achieve goals by organizing. Why do social organizations exist? People organize themselves because they believe that it is the most efficient way to reach their goals.

Organismic approaches regard an integrated system as a unit of analysis, which is something more than the sum of its components. It is not possible to comprehend a whole knowing only attributes of some components. There are complicated interrelationships and interactions between people and environmental components (Miller, 1978). J.G Miller in his book "The Living Systems" (1978) himself takes an example of the system theorists' concept of the world affairs and of the works by von Bertalanffy.

Sometimes a large-scale hierarchical system is efficient. However, for systems having the requirements of living systems together with the current level of human factor, we have no choice but to adapt the structure of the social network system presented in the given thesis.

Human factors are about people. It is about people in their relationships with activities and with environment (living environment and other behaviour settings) about them. It is also about their relationships with other people.

According to the systems view, systems as integral wholes have attributes which none of their components separately have. These attributes become evident in a fixed set of mutual relationships of the components and are not noticeable when these relationships or components are not any more in this set. Moreover, attributes of the components have a comprehensible meaning only in connection with the whole set and by themselves are not meaningful. In the systems approach, hence, the relationships are the object under examination, which, in turn, are components of some set of more general relationships or environment. Depending on the objective of the systems analysis there is a need to define the system, its components and environment.

The system examined in this thesis consists of central places and the settlement network formed of them in the context and environment of everyday life of people, and the respective relationships.

My presumption is that the development of a settlement system can be studied as being self-organizing. Self-organization is a cybernetic model to describe phenomena. Comparison of the rules of self-organization and attributes of social organizations is appropriate only under the assumption that these rules of conduct of the nature are applicable in general and in a similar way everywhere, including human community.

According to Hans Ulrich's ST Gallen model (Wheatley, 1999):

- A natural tendency of life is to organize. Life organizes into greater levels of complexity to support more diversity and greater sustainability.
- Life organizes around a self. Organizing is always an act of creating an identity;
- Life self-organizes. Networks, patterns, and structures emerge without external imposition or direction. Organization wants to happen.
- People are intelligent, creative, adaptive, self-organizing, and meaning-seeking.
- Organizations are living systems. They too are intelligent, creative, adaptive, self organizing, meaning-seeking.

Contemporary research analyzes social networks which contain a kind of hierarchy rather than hierarchical systems.

Analyses of settlement networks date back to the 1950s when in the Netherlands they were "growing" polders or were reclaiming land from the sea. On drained land they planned a settlement using the principles of the German settlement pattern founder Walter Christaller's model of hexagons (Central Place Theory). Though the settlement pattern on the Nord-Oostern polder started to work, the designed hierarchical system did not (Thisse 2000, 2002). It was found to be important to investigate also the factors that influence people in the decision-making and target setting.

Life also tends to form associations. According to Kohonen (1984, 2000), associations are formed on the following conditions:

1. if they occur simultaneously (spatial contact);
2. if they occur in close succession (temporal contact);
3. if they are similar;
4. if they are contrary.

Let us examine how social networks on the Baltic Sea islands are working and how associations are formed.

Living systems are not always balanced. Primarily in settlements one can encounter social cumulation effects caused by social gravity (Perroux, 1955). Magoroh Maruyama (1963) discussed that in the cybernetics the deviation-counteracting mutual causal systems and the deviation-amplifying mutual causal systems may appear to be opposite types of systems. The difference between the two types of systems is that the deviation-counteracting system has mutual negative feedbacks between the elements in it while the deviation-amplifying system has mutual positive feedbacks between elements in it (Maruyama, 1963).

Deviation-amplifying are ubiquitous: accumulation of capital, evolution of settlement systems, the rise of central places: in short, all processes of mutual causal relationship that amplify an insignificant or accidental initial kick, build up deviation and diverge from the initial condition. Maruyama (1963).

In this thesis our efforts focus on finding the initial conditions and causality of pattern behavior, which make some places more popular than others.

Maruyama presented a good example about development of a city in an agricultural plain. In the beginning a large plain is entirely homogeneous, the reason being its potentiality for agriculture. By some chance an ambitious farmer opens a farm at some spot on it. This is the initial drive. Several farmers follow the example and several farms are established. Somebody opens a tool shop, or a pub. Then the pub or the shop becomes a meeting place of farmers. A food stand is established next to the tool shop. Gradually a village grows. The village facilitates the marketing of the agricultural products, and so on. Maruyama describes traditional causality to places development.

2. Theoretical conceptions of the place identity

An interest in terms of a place is as old as the study of geography itself and the idea that such identities are created and recreated by the actions of people is, as we have observed, widely accepted. What is new? However, as borne out by many of the preceding case studies, there is an increasing interest of official representations and unofficial narratives of a place.

This research has its roots in two interrelated traditions: the cognitive mapping that is usually traced to the work of Lynch (1960, 1995), and environmental meaning tradition that grew out of the studies by Barker (1968), behavior setting theory. From various studies in this tradition, there is a wealth of information about the way different groups evolve in different places and their structure.

Lynch deals also with human sense of time and place philosophical perspectives on the past (heritage), present and the future: because every site has a long history that bears on its present. Every site will have a long future, over which the designer exerts only partial control. The new site form is only one episode in a continuous interplay of space and people (Lynch, Hack, 1994).

Lynch's original study, which was based on a small sample of people, has been replicated in various contexts. Lynch (1984) argued that `every case` the basic ideas held, with the important provisio that images are modified by culture and familiarity.

Throughout the present chapter we discuss this behavioral and cognitive perspective may detract from fuller understanding of how and in what way people inerrelate with their physical surroundings.

We affect the environment and are affected by it. Perception involves the gathering, organizing and making sense of information about the environment. (Lynch, Hack, 1994).

The key idea of Umberto Eco (1968) is the layering of meaning and functions. Meaning of the primary function of objects is the function that facilitates it. The secondary function is that connotation, and is of a symbolic nature. Eco shows that the secondary function can be more important than the primary one. The secondary order meaning enables differentation to be made between objects, like social (life-style) and economic forces (commodity and other).

The symbolic role of environments is a key part of the relationship between society and environment.

Having covered environmental perception/cognition and generation of environmental meaning, we will discuss the ´sense of place´. Sense of place is often dicussed in the terms of the latin concept of ´genius loci´, which suggests that people experience something beyond the physical or sensory properties of places, and can feel an attachment to a spirit of place (Jackson, 1994, Carmona, Heath, Oc, and Tiesdell, 2003).

As mentioned in the Introduction, it is not always clear what is exactly meant by `place identity`. Sometimes it is described in terms of culture, particulary local music, folklore or culinary specialities. Often, a place derives its identity from the landscape or built environment. Place identity is also derived from regional economic activities or products. The identity is used for `place marketing`, in tourism and attracting new residents or investors (Huigen, Meijering, 2005). A place has to have a "face" to succeed in marketing terms. Heritage may be the outstanding place characteristic, which is related to the face of place.

This summary of the various approaches to the use of the term ´place identity´ shows that it is not a completely transparent concept.

There can be several perspectives, like individual and communal initiatives.

The institutionalization of the sense of place through the heritage policies may also enhance the degree of dissonance that can exist between communal and individual perspectives on place and time. By virtue of this comes an immediate practical question: What is the local identity that is being sought and how can it be recognized? It should be stressed that there is no explicit mention in the policy documentation of any national stereotype of landscape whose local manifestation is to be sought. If it is assumed that the country is a palimpsest of localities which are defined by some common collective identity than that poses the same question, as did collective memory: is this an aggregate summation of a myriad of individual identities or something quite separate and plausibly different? In addition, as an example, in the Netherlands, under-riding assumption of the Belvedere programme is that coherent national identity is shaped from the myriad of locals. This contrasts with unagreed societies, as for example in Northern Ireland, where the same palimpsest has no sense of commonality (Ashworth, et al., 2005). Thus, the Netherlands seems to suggest a model of comfortably nesting identities, ranging in size from the single individual to the largest collectivity applicable, whereas Northern Ireland suggests that models of conflict are more relevant. Northern Ireland has changed through time to incorporate different conflicts. In the Netherlands, conversely, place, time and heritage are dynamically linked in the broadest realm of spatial planning, the country providing what is perhaps the best example of the conflicts

and tensions that emanate from the integration of senses of place and time into the physical planning process.

The Dutch model is similar to the Estonian islands' model, with that the only difference that in our conditions dichotomy occurs between different social groups. Our research is based on the theories of Paulus Huigen and Louise Meijering (2005) (6).

2.1 Place identity as a social construct.

Place identity is something that is attributed to a place by people. The crisscrossing of social relations and socio-cultural significance, of broad historical shifts and the continually altering spatialities of the daily lives of individuals, make up something of what a place means, of how it is constructed as a place.

The mutual constructing of the identities of the people and identities of places is a constant process. Buildings, therefore, as precipitates of social relations, are being changed by them and have a life within them.

The "architecture" of the settlements is also the frame of social relations. (Massey, 2002). The spaces of social relations are constructed, just as buildings are constructed; they can be adapted, as buildings can be adapted; they are not "material" as buildings are material, but they can be as hard to walk through as a wall. This is an immaterial architecture: the architecture of social relations. And yet, social relations are practiced, and practices are embodied, material (physical). Places are the product of material practices (Massey, 2002).

According to Paasi (1991), giving a name to a place is one of the basic activities in the place identity construction process. The name distinguishes the place from other spatial entities. A place is created when we attribute to it the quality of being ´distinct´ from another location and have a name. Lynch (1960, 1995), Rose (1995), Thrift (2000) distinguish two processes of identity attribution: (i) identifying with a place involves attributing an identity to it based on positive feelings of connection with that place. That implies being in that particular place makes feelings, like `at home`, familiar, friendly, ´at easy` etc., (ii) identifying against involves attributing an identity to a place that is based on negative feelings, it attaches such qualities as ´anxious´, less familiar up to dangerous. It means, typically, `identifying against` often relates to ´other` - less familiar – places, which tells more about the perceptions and culture of the person than about the place. The attribution process may take time. If individuals create place identities, then obviously different people, at different times, for

different reasons, create different narratives of belonging. Place images are thus user determined, polysemic and unstable through time.

This means that an identity evolves continually and consists of several cultural and chronological `layers`. It is a social construct that embodies elements also in the desired situation (not only from past and present).

It seems that people with similar interests form social constructs.

According to Robertson et al. (1994) there are two questions of identity which can be defined as `the story we tell of ourselves and which is also the story others tell of us`. Many different identities – individual, group, and place – can be distinguished. The relation between place and identity is important (Teather, 1999, McHugh, 2000, Mitchell, 2000) and changes in place usually impact upon identity formation at least to some degree.

As with many areas of policy, including particularly those relating to the conservation of the natural and cultural environment, the question as to who is making decisions becomes intertwined with the decisions themselves. In this case, it may be as important to determine the identifier as that which is being identified. Here we return to the issue of the management functions to discuss of insiders and outsiders. Potentially, this creates the situation in which outsiders define the sense of place of insiders who are informed what their recognizably distinct local identity might be.

2.2 Place identity based on the characteristics of the place

Senses of places are therefore the products of the creative imagination of the individual and of society, while identities are not passively received but are ascribed to places by people. People do often assume identities are intrinsic qualities of landscapes, but not only.

Place identity is based on the characteristics of the place. Place identity attribution is not a random process. Actors, people in their organizational setting: households, businesses, institutions, attribute an identity in order to achieve certain implicitly or explicitly stated goals (Huigen, Meijering, 2005). Actors link the attainment of their goals to the perceived features of the place through the place identity. The actor bases the identity on the distinguishing features of the place, which are often considered as characteristics and identity markers. The characteristics of the spatial environment can also be seen as features of the place:

Naturally, it is not enough to conclude that places are imagined entities.

2.3 Place identity is to a large extent based on the past

Lynch (1972,1995) observed the place as an emblem of past, present and future time, that every site has a long history that bears on its present. If place identity is largely based on the characteristics of the place, as it was perceived in the past, Lynch (1972, 1995) discusses how environments change, and expresses some thoughts on the relation (or lack of relation) between environmental and social change. However, personal connections are most effectively made by personal imprints on the environment. Since the future is unknown, the past plays an important role in identity attribution.

This refers to several questions about the links between senses of time and place. Heritage draws upon elements of history, memory and selective relict artefacts as resources to effect a self-conscious anchoring of the present in a selected time context (Ashworth, Graham., 2005). Heritage of a place is simultaneously knowledge, a cultural product and a political resource (Livingstone, 1992, Ashworth, Graham, 2005).

It is apparent that heritage takes a variety of official (state-sponsored) and unofficial forms, the latter often being subversive of the former. Heritage is also contested along several different axes – the temporal, the spatial, the cultural-economic and public/private, it also functions at a variety of scales in which the same objects may assume or be attributed different meanings (Graham, 2000, 2002). Hence, heritage is part of the wider debate about the ways which regions are being seen as the most vital sites within which to convene and capitalize on the flows of knowledge in contemporary globalization. Networking, entrepreneurialism, collaboration, interdependence and a shared vision are all vital prerequisites for regional economic regeneration. Simultaneously, other institutions are also involved in strategies that can serve to circulate and capitalize on existing and other sources of knowledge (MacLeod, 2000), heritage among them.

But the dominance of past raises dangers of creating identity based upon social and cultural elements that are already obsolete and largely irrelevant to the daily way of life of most locals, while also possibly fossilizing past or present patterns in a way that will inhibit future change.

Manuel Castells (1996) argues that cultural expressions that he terms the network society are abstracted from history and geography and become mediated by electronic communication networks. These latter, which allow labor, firms and regions to produce, circulate and apply knowledge, are fundamental to growth and competitiveness.

Castells sees a world working in seconds while the ´where´ questions – such as environmental quality and sustainability – are in long-term, ´glacial´ time. Power, which is diffused in global networks, lies in the codes of information and in the images of representation around which societies organize their institutions, and people build better lives, and decode their behavior. The sites of this power are people´s minds (Castells, 1997).

2.4 Place identity is debatable

Every society is composed of different actors with different goals, who therefore attribute with different identities to a place. This means that place identity is always open to debate (Huigen, Meijering, 2005). Actors who are powerful in terms of authority and/or resources can impose their dominant place identities at the expense of other actors. Different actors will always attribute different identities to a place.

It is therefore advisable to refer to place identities in the plural.
The places have a different identity and rate of the identity for people.
There are the places by default being declared `identity-poor` or even `identity-less`. Do the inhabitants feel no sense of place or only that their place has an identity that is less easily recognizable or less valuable than somewhere else? **The idea of the existence of an ´identity value surface`, which at least in theory if not in practice, could be mapped, points to some intriguing possibilities with applications in the geography of decision-making.**
Such questions return the discussion to the differences between the official reliance upon the more universally recognized physical attributes of a region, and intangibles that contribute most strongly to an individual´s unofficial collectively unendorsed sense of place.
It cannot also be assumed that there is one single identifiable collective place identity. Society is diverse and these many diversities will result in equally diverse place identities. Like the sense of time transformed into heritage, the user creates place identity.

2.5 Place identity is attributed within a particular context

Place identity is attributed within and characterized by, a particular context.
Given this intrinsic variability in time, through space, and between social groups, it may seem perverse to attempt to generalize at all about a phenomenon that relates ultimately to a particular individual person, moment and location. The concept of collective identity does not

supersede or replace individual identity. It does, however, allow generalization and the location of ideas of belonging within social contexts.

The spatial context or location can be labelled with the classic socio-geographical term ´geographical situation´. The third context is a socio-cultural context, which consists of the prevailing norms and values of society. This includes social and economic circumstances and relationships, as well as spatial planning trends relating to the structure and function of places.

2.6 Place identity is a continuing process

Place identity is that its identity attribution is a continuing process in which new actors establish themselves and goals and ideas change. Identity changes continuously: it is fluid (Hatty, 1996). As mentioned earlier, if individuals create place identities, then obviously different people, at different times, for different reasons, create different narratives of belonging. Place images are thus user determined, polysemic and unstable through time.

Place images do not simply come into existence. They are created by and through processes of identification which are both internal to the individual or group and external.

Therefore, the context within which the actors are located also changes. Place identities evolve continually, but at the same time established identities are confirmed. They are then reproduced in the conduct of the place and the way in which it is represented through communication information exchange (Huigen, Meijering, 2005). Identities are constructed and reconstructed, this process follows a certain path over time. Along that path we find identity markers, characteristic objects and events that define the evolution of the path identity. The future construction of place identities is determined by several factors. According to Huigen and Meijering (2005) two factors of them are most important: the first is evolutionary and involve Kevin Lynch's (1960, 1972, 1995) idea that every situation in the present and in the future is inevitably rooted in the past. Evolutionary process follows a certain path over time. A current place identity and its historic component form the basis for the future identity.

The second factor is unexpected events, the substance of which, by their very nature, cannot be known in advance. Although the evolutionary path is a determining factor for the future of a place, it should be balanced against the occurrence of unexpected developments. The development process itself has functional dimensions, temporal dimensions, and time cycles.

In the context of dynamic life, the strengthening of local identities as a counterpoise to increasing economic and cultural globalization, which is seen as threatening to produce a

homogeneous universal ´global village´ that is assumed to be undesirable (Ashworth, Graham 2005).

In conclusion, the place identity is based on a point in time and the social construction of the place: it is socio-cultural significance.

Place-identity attribution is not a random process. Actors (people in their organizational setting: households, institutions, businesses) attribute an identity in order to achieve certain implicitly or explicitly stated goals. Actors link the attainment of their goals to perceived features of the place through place identity.

That idea is supported by (Bourdieu, 1999, Paadam, 2003). According to them the physical or geographical places are associated with social distances between people in different positions. They suggest that the differentiated social space, based on the possession of differentiated volume and structure of capital, tends to have strong inclination to be explicitly reflected in the differentiated spatial context of people´s everyday lives` (Bourdieu, 1999, Paadam, 2003). It is important for our study that Bourdieu (1999) does not conceive of spatial segregation as of an absolute condition. People from different social positions can intermittently interact in the ”invisibility“ of social distances. The idea of social construction is accompanied also by cognitive characteristics which characterize human relations: friendly places attract people, similar attracts similar.

Every society is composed of different actors with different goals, who therefore attribute different identities to a place. Actors who are powerful in terms of authority and/or resources can impose their dominant place identities at the expense of other actors. Different actors will always attribute a different identity to a place. It is therefore advisable to refer to place identities in the plural or characterized as a struggle.

3. Theoretical considerations on the basis and conceptual framework

Work on hidden dimensions and assumptions in physical environments by Edward Hall (1966) raised an interest in social factors among human geographists. Today the study of the social environment is often referred to in terms of human spatial behavior and territoriality (Aiello, 1987).

Effective research application has always been an important but illusive goal in environment-behavior research. This tradition, coming principally from geography and psychology, has focused on exploring the content and structure of "deep" semantic representations of the environment using the IS methods.
This theoretical research has its roots in two interrelated traditions: the cognitive mapping that is usually traced to the work of Lynch (1960, 1995), and environmental meaning tradition that grew out of the studies of Barker (1968), especially as they were developed by Golledge (1991), Massey (2002), et al.

Below attempts will be made to understand representations of the environment that mediate between the physical environment and human behavior.

3.1 Spatial choice behavior and decision making

Through the analysis of the nature of research into environment and behavior, an idea of a two-community model for Estonian islands Saaremaa and Hiiumaa was developed.

Different places can be recognized and organized into coherent pattern in people´s minds. The connection between environmental cognition and use has been explored in great detail in social and behavior geography.
The most behaviorally oriented of these studies are those of Barker and his colleagues 1968, carried out when they were developing their own brand of ecological psychology and behavior setting theory. Although later writers in this tradition, notably Wicker 1987, have eschewed a purely behavioral focus, their emphasis is still on observable phenomena. The emphasis is on what people do, whether it is their attendance or participation.
Wicker (1987) is using this approach in a study of the history of behavior settings.

Timmermanns and Golledge (1990) give many typical issues to studies on the relation between spatial awareness and actual behavior. Considerable evidence has been accumulated on the causal relations between environmental accessibility and use (Hanson 1978, 1984; Potter, 1979, Timmermanns, van der Heijden, Westerveld, 1982). These causal links imply that making the environment more knowable leads to increased accessibility to resources and greater life-style alternatives.

Reversing the perspective, and examining the key role in determining action that is played by environmental knowledge and evaluation. Hart and Conn (1991) stressed the functionality of much of individuals place knowledge.

Both elements in an environment and elements of an environment are held together in a matrix of processes. According to Golledge (1991), the generic term ”process“ implies temporal change.

In this chapter we will discuss the basic spatial elements or components that allow both differentiation and clustering of phenomena found in large- and small-scale environments.

A spatial process thus becomes a mechanism for inducing a change that does not act simultaneously and in the same way at every location in a spatial system.

Spatial processes involve spread over space, given that space is a barrier that must be overcome as a course of action spreads throughout a system. Evidence that the process is in operation appears at different places at different points in time. Processes are continuing courses of action that in theory have infinite life spans.

Kurt Lewin´s (1952) concept of human behavior based on the dynamic organization of behavior developed a transactional theory that emphasizes that a person’s behavior at any point in time is the result of the holistic organization of personal and environmental forces acting with people´s “life space”.

Valsiner´s (1987) model inherits that the physical environment is meaningfully organized – made up of places, objects within places, and different actions that can be performed with objects.

Environments are organized structurally (Golledge 1991). Even the physical environment encompasses the markedly dissimilar worlds of landforms, marine, surface domains, vegetation, etc. (Golledge 1991). Elements in an environment include inanimate objects, behaving life forms, and structural and behavioral processes. The processes of space generally include the ongoing actions of energies and forces that hold all parts of a space together.

Elements in a space exist within its boundaries and represent the features that can differentiate one place from another.

The most fundamental unit in any space is an occurrence. By definition, an occurrence occurs in space (Golledge, 1991). According to Golledge (1991), identity is a label that can be attached to an occurrence.

Occurrences need in addition to a label or name, a statement of existence. We use the term "location" as an indicator of existence.

All environmental cues are associated with some location. Thus members of the general cue classes discussed in the previous (or next) paragraphs are made place specific by attaching locational descriptions to their identity.

Golledge (1991) provides a detailed discussion of possible links between environmental description and cognitive representation. He argues that the basic elements in a setting are life forms, objects, and behavioral processes. And elements (places) have identity, locality, magnitude, and temporal existence. Golledge is concerned with how different kind of knowledge, such as landmarks, routes, and overall configurations, become integrated into a common knowledge structure that, in turn, guides recognition and evaluation of objects and situations in everyday life.

Timmermans, R.Kaplan and Golledge (1991) are arguing that the cognitive representation of the environment is an important mediator of the relationship between the environment and everyday behavior. Golledge is more explicit in suggesting the nature and structure of this representation as being hierarchical and dependent on specific features such as regions and anchor points.

From the 1970s and onward, different types of behavioral choice models have been advanced, but most models of spatial choice behavior are based on an observed behavior.

A fundamental problem with the observed behavior is that it may not be the result either only or mainly of individual preferences. For example, patterns of housing market choice are likely to be influenced by constraints derived from personal, environmental, and social factors. The effect of these factors on observed choice patterns cannot be readily determined (Timmermanns, 1991).

Developing social aggregates formulated in analogy to models of physical processes. Models such as the gravity model (Reilly, 1931) and the entropy-maximizing model (Wilson, 1974), were not primarily concerned with individuals choices but rather with interzonal orientation or interaction patterns, which result by aggregating individual choices across zones. The

aggregate people are watching social processes and gather where there are other people ahead; it can be explained by the theory of agglomeration, including the gravitation model, but it does not answer the question why people choose one or another place, why they agglomerate in one or another place.

Modern research has extended the study of decision making also into the spatial context. Personal or group engagement with space gives it meaning as place, at least to the extent of differentiating it from other places. Sense of place is, however, more than this. Already Lynch (1960) defines identity of place simply as that which provides distinction from other places.

3.2 Territoriality

Physical environment and a person are not directly related, but their relationship is realized through a metasystem. Dependence of behavior on a behavior place does not require being aware of the whole behavior place. People also carry out only part of their possible behavior place programme.

Barker not only studied the elements of behavior places or people, but also classified the behavior places.

Territories and the related territorial behavior might be related to different motives and needs, different geographical phenomena, different social units and these behaviors may have different duration in time, different behavioral patterns.

Altman (1987) distinguishes between three types of territories:

1. Primary – spaces used or owned by individuals or a group of people, which are accepted with the attitude of other than their own. It has a central importance in everyday life, e.g. home.
2. Secondary – less important for people, less unambiguous and less exclusive, e.g. corridors, clubs, street cafés where virtually everyone may come and go without incident; the book ”Defensible Space” by American sociologist O.Newman describes it quite well.
3. Public territories – generally accessible to anyone and used on a temporary basis (city parks, public beaches). Sometimes some restrictions have been imposed on public territories, which are more general than in the case of primary and secondary environments.

The distinction is based on (1) continuity of social contacts in a given framework; (2) psychological significance of the activities performed in the framework; (3) the degree of

individualization and anonymity of the relationships with other inhabitants of the environment.
Primary environments – where one spends most of the time, related with other people on personal basis, where one performs most of the important activities. Secondary environments are such where contacts with other people are temporary and insignificant.

According to Barker's theory of behavior places, territoriality means quite a persistent relationship between the person and the place.
There is a growing concern for the functions of human territoriality:
For example, territoriality has an organising and stabilising function of a human behavior.
Common territory contributes to social contacts inside a group (Edney, 2006).
A territory also creates previously experienced role expectations and makes particular behavioral patterns more likely and through this also reduces the amount and complexity of information.
Territory also contributes to the birth of integrated behavior chains, as we need not pay so much attention to what is happening outside. Edney (2006) suggests that loss of a territory involves instability in behavior.
In the Barker's environmental concept it is not possible to describe the behavior of a person without taking into consideration his direct relationships with the environment. A behavioral environment is similar to any biological or physical whole. This is an objectively organized, self-regulating system, which is actively and purposefully influencing its components and on each level different kind of phenomena and processes are subject to regulation. Barker set a task to join both environmental and individual behavior into one explaining system.
Today increasingly more questions concerning planning are being asked – how people perceive this space, whether they have an adequate understanding of its structure, or have some regions completely disappeared in their imagination depending on where they themselves are moving (Jauhiainen, 2005). This area has also recently moved from a purely planning way of thinking toward cognitive thinking.

The period since the 1970s has seen increasing interest in the examination of people´s ties to and conceptions of places. While the meanings of places are rooted in their physical setting and activities, they are not a propery of them, but of human intentions and experiences. Hence, what the environment represents is a function of our own subjective construction of it. Dovey (1999) sees phenomenology as a necessary but limited approach to the understanding

of place, since the focus on the lived–in experience involves a `certain blindness´ to the effects of social structure and ideology on everyday experience (Carmona, Tiesdell, et al., 2005). Habermas makes a useful distinction between life-world, the everyday world of place experience, social integration and communicative action and the system, the social and economic structures of the state and market (Dovey, 1999).
It is often argued that people need a sense of identity, of belonging to a specific territory and/or group. Crang suggested (1998) that places provide an anchor of shared experiences between people and continuity over time. Norberg-Schulz (1971) argued that to be inside was the primary intention behind the place concept. Similarly, Relph (1976) distinguished types of place identity based on the notions of ´insiders´and ´outsiders´.

The concept of inside-outside is most easily understood in terms of territoriality, people's definition and defence of themeselves – physically and psychologically – the creation of a bounded, often exclusive, domain. Territoriality is frequently the basis for the development of distinctive social milieus that mould the attitudes and shape the behavior of their inhabitants (Knox, Pinch, 2000). Typically this occurs at, and makes explicit the threshold or transition between public (group) and private (individual) domains.
A.Wicer (1987) is of the opinion that the territorial aspect of behavior places can be regarded as regions with an adequate number of population. The existence and survival of a behavior place is ensured by an optimal interval of population, which is smaller or equal to the capacity of that behavior place but bigger than the so-called preservation minimum. Deviations from the adequate state are possible in both directions. When there are fewer candidates than the preservation minimum, then the behavior place is underpopulated and when the potential participants are more numerous than the capacity, then it is overpopulated. When the deviations are too big, then the behavior place either becomes extinct or turns into another behavior place. Its programme will change.

3.3 Beyond the rationality

Foa (1971), who criticized the rationality model, has perceptively demonstrated that even among a limited set of desirables (goods, money, status, recreation, leasure, love, information, and services) translation cannot occur without a substantial loss. For example, if one likes to have holidays on island, he should be willing to pay for it. Kaplan´s (1991) criteria about the people´s destination choices are *knowledge-related* and *adaptive*, but he himself inclined

toward an *information-centered model of choice*. Because it must be cognitive in the sense that it reflects an individual´s state of knowledge or ignorance. At the same time it must have affective consequences; possessing pertinent knowledge must engender positive feelings and encourage action while ignorance must have the opposite effect. The concept that possesses these necessary qualities is cognitive clarity. Intuively this concept refers to the clear state of mind that accompanies comprehension and that acutely lacking during states of confusion.

From the point of view rationality model, a particularly pertinent discussion of the motivating effect of cognitive clarity is set in the context of the resistant paradigm shift in economics (Kaplan , 1993). Earl (1983b) proposes six motives or goals to explain why academic economists have not abandoned the traditional (rational) economic model despite its evident inadequacy. One of these goals is (to keep situations of unfamiliarity within particular tolerance bounds (anxiety-avoidance aspiration). That Earl is referring to something closely akin to clarity is evident from his book *Economic Imagination* (1983a), in which he states: ”human behavior can usefully be seen not as evidence of hedonistic, ´utily seeking` activities but has the manifestation of attempts by people to reduce to mysterious nature of the world around them.“

The factors that influence choice might be helpful at this point to provide concrete imagery, and to give a sense for the pervasiveness of clarity´s influence on decision making. To make a choice between two or more alternatives one has to know how much one likes or values or prefers each of the alternatives.

What this means is that one cannot approach this more realistic and more complicated way of framing a problem by cosidering each specific possible path: rather one has to evaluate the space as a whole. The space includes the knowledge one has of where one is, where one wishes to go, and the various paths. Some spaces allow more alternatives if something should go wrong: some spaces are friendlier because one knows more about them. The admonition ”You gotta know the territory,“ reflects this recognition that effective behavior depends on knowledge of a larger space, even though it is impossible to predict what aspect of this knowledge will be useful” (Kaplan, 1993). The cognitive and hidden structure that reflects knowledge of such a space corresponds remarkably well to what is usually referred to as a cognitive map.

Based on the discussion of links, paths, and maps, we can now turn to the role of clarity in the perceived ”goodness“ of a possible choice. Put simply, clarity of choice depends on the cognitive structure that represents the extensive problem space which the choice is embedded in.

3.4 Social and environmental complexity

A phenomenological orientation, for instance, might suggest asking questions about the interaction or integration of environmental knowing and experience, whereas a structural orientation might direct one to ask questions about the underlying or deep structure behind more manifest images of the environment (Moore 1991).

On the other hand, relationships are the most important part of our lives. Interaction and relationship refer to distinguishable levels of social complexity. One of those is that the physical environment influences and is influenced by each level of social complexity so far mentioned. The other is the sociocultural structure, or system of beliefs, values, myths, conventions (Giddens, 1997), ec.

Anthony Giddens (1997) introduces the concept of structuration: a process of structuring the social relations across time and space, in virtue of the duality of structure. Analyzing the structuration of social systems means studying the modes in which such systems grounded in the knowledgeable activities of situated factors who draw upon rules and resources in the diversity conext, are produced and reproduced in interaction (Giddens, 1997). Giddens says that duality of structure is fundamental to his theory of structuration by indicating that the conditions and consequences of action are embedded in the contextualities of social interaction.

The dicussion of the cognitions, actions, and evaluations that constitute the experience of places inevitably takes the emphasis away from physical aspects of places and looks toward personal and social processes. Yet one intention has been to clarify the picture of place experience well enough to allow the role of the physical environment to be more specifically identified.

It is certainly clear that the human experience of the environment, the significance of the physical attributes of place is a complex product of their context within a social-psychological matrix, and after that comes physical shape and environmental multidimensional structure.

Two separate aspects of the physical context are indicated here. These relate, on the one hand, to those aspects of places that represent and reflect the people (and their activities) who experience those places. On the other hand, they draw on the relationships between places that provide the framework within which the social rule systems operate.

The first set of relationships can be seen as rooted in the declarative knowledge that people can draw from their transactions with places. This is the knowledge about the people and actions that are either housed within or associated with places. This might be expected to

include such ideas as knowledge of how a place was created, as reflected in its use materials or other details of it, or knowledge of the way relationships between places imply relationships between people. Within this framework the size and shape of places take on a significance that derives from their implications within the social matrix. A school, a place for living, will have different consequences.

The second set of physical implications derives from the procedural relationships between spaces and the associations they carry for the rule system of place use. To tackle this approach to physical form we need to develop a more elaborate understanding of the rule systems that structure place use. Such research would explore the various types of rules that exist and how rules relate to each other, forming the matrix of expectations and limitations that underlies any social network.

Perspectives from which physical forms can be seen to be psychologically significant, but this significance is derived from the social processes with which they interact (Böök, Kaplan, Küller, 1991)

The physical shape of the environment does not have direct significance for cognition, action and evaluation. Its significance comes from the ways in which it enshrines procedural and declarative knowledge about the people and actions that the place can or may encompass.

The world may be organized around a set of focal points, or broken into named regions, or be linked by remembered routes.

Knowledge structures of the environment rebound in the cognitive maps.

Pressure on environmental psychology as contiguous discipline to contribute knowledge about how the physical environment affects has led to an analysis of human-environment system that takes starting point factors in the physical environment.

In the discussion of place rules, environmental roles, and physical forms, Canter (1977) stresses the need to incorporate the social as well as the physical forms. An appropriate focus is individuals´ overall functioning or adjustment in their environments and the role the physical aspects of these environments play in that functioning. These processes include cognition, assessment, and action.

Cognitions are seen as being shaped by individual´s purpose or plans for his or her actions in the environment. The very term action implies deliberation and goal orientation. Assessment may then be best understood in terms of the purposes that different places are perceived to support or counteract.

Physical form and the spatial distribution of activities are partly contained in the traditional "land use" categories. According to Lynch (1960) it is true that their very ambiguity is often useful in field operation, where they can be made to mean what the user wants them to mean. But for a theoretical study these categories thoroughly confound two distinct spatial distributions: that of human activity or "use" proper, and that of physical shape. The pattern of activities and the physical pattern are often surprisingly independent of each other and they must be separated analytically if we are to understand the effect of either (physical patterns, activity patterns) (Lynch 1991).

In this country´s climate, the key spaces of this nature of those enclosed and with a modified climate, that is, the places floor space. Almost everywhere, however, the adaption includes some modification of the ground plane, even to the cultivation of a field, and the key activities are often likely to take place in at least sheltered, if not enclosed, spaces. But in any case, the fundamental thing done to our physical environment, besides providing means for communication, is to provide spaces for various activities, people adapt the quality of those spaces, and to distribute them in an overall pattern.

3.5 Rules of place

Concepts of place often emphasize the importance of a sense of belonging, of emotional attachment to place. Place can be considered in terms of `rootedness`and a conscious sense of association or identity with a particular place. Rootedness refers to a generally unconscious sense of place. Arefi (1999) suggests it is the most natural, unmediated kind of people-place tie. For Relph (1976) it meant having a secure point from which to look out on the world, a grasp of one´s position in the order of things, and a significant spiritual and psychological attachment to somewhere in particular.

The environment can be considered as a mental construct, an environmental image, created and valued differently by each individual. Images are the result of the process through which personal experiences and values filter the barrage of environmental stimuli. For Kevin Lynch (1960) environmental images resulted from a two-way process in which the environment suggested distinctions and relations, from which observers selected, organized, and endowed with meaning what they saw. Similarly, Montgomery (1998) distinguished between `identity`, what a place is actually like, and image, a combination of this identity with perception of the place by the individual with their own set of feelings about, and impressions of it.

There are numerous studies that examine the use that people make of places. These studies focus on human behavior, looking at matters such as interpersonal distances, density, the distribution of people over space, and social structuring of human activities.

Barkers perspective identifyng units of social behavior have natural occurrence - behavior settings (Kaminski 1983). This structuring of the social world of the individual into discrete units that have a finite existence in time and place, together with a recognizable set of actions and roles that maintain that setting, provides a powerful description of place-related actions (Canter, 1991).

Barkers original work was fundamentally descriptive, but more recently Wicker (1987) started to give some account of how settings emerged and are controlled. The processes by which behavior and setting shape each other are also being explored. Yet it is still the case that the actual physical use of space is rarely examined within the context of Barker´s ecological psychology. Settings are defined in terms of their physical boundaries, but beyond that the considerations of behavioral ecology are firmly wihin the social and organizational framework.

By contrast Altman´s (1987) social-system approach examines the physical distribution of people in space. In doing this he linked together explorations of crowding, territoriality, and personal space by arguing that they all derive their significance from successful or unsuccessful attempts to produce an accetable level of input in relation to output.

By providing a focused objective for a variety of spatial behaviors Altman turned the coercive, setting-dominant, and fundamentally behavioral orientation of Barker into a more dynamic picture.

The effective use of a setting implies that it has in Barker´s terms a ”program“, in other words a set of expected roles, relationships between people, and rules for how those roles are acted out. Within this framework the studies of spatial behavior are studies of the socially formed rules of place use. Certain distances are learned as being appropriate for certain types of activities in certain settings (Canter, 1991).

In other accounts these have been called ”rules of place“ (Canter, 1991) to draw attention to the ways in which human actions fit into the place in which they occur.

The use of the term ”rules“ probably lacks the subtlety necessary to capture the mixture of percepts, customs, and habits associated with place use and future research will undoubtedly need to elabotate on this concept. Nonetheless, the idea of place rules serves to summarize the

extent to which the study of spatial behavior has discovered forms and patterns of place use, and the extent to which these patterns are embedded in social and cultural processes.

By seeing the social processes as the dominant theme in this spatial composition it is possible to recognize that people are acting in places by relating to the rules of place use. These rules are followed, implicity or explicity, though, in order to act within (or against) the actions that are physically or socially possible in that place.

The discovery of place rules may be seen in a number of very different types of studies. For example, from its earliest use, behavioral mapping (Ittelson, Rivlin, Proshansky, 1976) has demonstrated that behavior is not randomly distributed across spaces. This is true even if those spaces are relatively undifferentiated and not bound by very strict precepts about their use. Different types of people or different activities tend to cluster in different areas of any space. From this the self-fulfilling cycle elaborated in Canter (1977, 1991) can be seen to emerge, giving rise to the observed patterns of place use.

The evolution will arise, in part, out of the assessment individuals and groups makeof the fit between their knowledge of the rule systems in operation and their understanding of what is possible, appropriate, and desirable in a given place.

Canter´s (1977, 1991) argument is that people differ in their reasons for being in places. Therefore they have different purposes and goals in those places. It follows that their patterns of action and their associated cognitions in those places will be different. Most of these purposes and goal-directed actions derive from the social organization of which a person is a part. Taken together , then it is being proposed that the experiences that relate a person to a place, are the key distinguishing features that lead to individual differences in regard to place experience.

3.6 Environment, cognition and action

This separate section will focus on environmental action, cognition and knowing.

The emphasis on rules of place, rather, than simplify patterns of space use, has the special value of providing a strong link to environmental cognition. Putting it as its most elementary level of analysis, rules of place use would not emerge and remain if there were not some shared understanding of their existence. This does not require that people are necessarily aware of the rules or can articulate them, but it does require that they can recognize appropriate environmental cues, relevant to the patterns of place-related behavior. In other words the behavioral patterns and environmental cognitions are interdependent. One can not

occur without the other. People can develop an environmentally appropriate behavioral repertoire with appropriate environmental cognition.

What we know and understand about our surroundings influences our evaluations of and behaviors in the physical environment. Our reasons for using places, our goals and personal plans, bias the manner in which we aquire and store knowledge of places (Evans, Gärling, 1991). The extent to which places afford the goals and plans we bring to them also affects decision making, action in real-world situation, environmental assessments and cognition.

Environmental cognition encompasses the cognitive processes involved in the aquisition and representation of predominantly spatial information in real-world settings (Evans, 1980, Golledge 1987, 1991, Moore 1979, 1991). Real-world settings differ from the stimuli used and the stimuli occur in some spatial and temporal context, involve a user who is interacting with the space in a dynamic way (Ittelson, 1973). The person trying to develop or utilize a cognitive representation of a real-world space usually is doing so in concert with one or more plans that involve actions in the setting. Information from the environment is selected and processed in the context of purposeful actions (Gärling and Golledge, 1989, 1991). Physical characteristics of settings can influence environmental assessments (Kaplan, Kaplan, 1989, 1991).

What is the nature of people´s cognitive representations of physical space in actual environments? Propositional models of representation have emphazised schematic aspects of spatial representation that provide organizational frameworks and general rules for storing information about spatial relation in actual environments. Most people have general rules about spatial knowledge that they apply to real-world spaces.
People also have schematic representations for familiar, well-used environments. They develop cognitive maps that include information about important features of the geographic environment such as landmarks, path system and subareas and important places (Lynch 1960, Appleyard, 1976).
A minor part of the study analyzed the effects of experience of familiarity, gender, age and to a lesser extent, culture of environmental cognition.
Considerable topic of interest has been how physical elements in the environment affect environmental cognition. Environmental features such as landmarks or pathway configurations affect the aquisition and storage of spatial information in the environment.

My assumption is that an individual receives information from external environment and his response of environmental stimuli or output termed action occurs. The existence of motives, goals and attitudes toward action alternatives is taken for granted.
In human geography, the formation of plans and their influence on actions in the environment is a topic of increasing interest: how individuals make decisions about how to choose and act in real-world environments (Golledge, Timmermans 1988; Timmermans, Golledge 1990, 1991). Such actions have been conceptualized as a process in which an individual perceives and forms preferences for different action alternatives (for instance, travel destinations). A person decides which alternative to choose according to some decision rule that takes into account preferences for the alternatives as well as constraining factors (e.g., budget, time). The individual implements the choice in an overt action. Cognitive factors such as previous experience, perceptual and representational abilities, hierarchically organized goals, and decision rules are assumed to affect the representation of the environment as well as individual choices and their implementation. Because actions in the environment are viewed as the implementation of decisions and decision-making process rather than actions themselves.

The perspective of physical environment focuses primary on how aspects of the physical environment impact cognition, assessment and action. The physical parameters of objects, their arrangements in space, and the overall organization of features in settings influence assessment, cognition, and decision-making and action in real-world environments. Examples of physical properties discussed include complexity, landmarks, route configurations, land-use compatibility, size, mystery, thematic structures, and socio-cultural and symbolic elements (Gärling, Evans, 1991).
How do you categorize the environments? How do people encode, store, recall and use environmental information? Below is a review of the conceptual underspinninings of the author's research of spatial choices in physical environments. Examples of such everyday spatial choices are the choice of a new residential location, the choice of the shopping locations to patronize, and the choice of locations for leisure activities.
Environmental assessment is fraught with hidden assumptions of many kinds. Description is based on categories, the choice of categories is often not explicit (R.Kaplan, 1991).
Environmental assessment is closely related to the impact environments make on people. (Küller, 1973).

There are many good reasons to measure attributes of physical environment, but the question is - what is important and valued in terms of human functioning?

Environmental images are the result of a two-way process between the observer and his environment. Thus the image of the given reality may vary significantly between different observers. The observers are grouped in more and more homogeneous classes of age, sex, culture, occupation, temperament, or familiarity. Each individual creates and bears his own image, but there seems to be a substantial agreement among members of the same group (Lynch 1960).

Researches in the environment-behavior area have also proposed theories that bring the human and the environment into a common context. In terms of the needs of environmental assessment, many of these theoretical efforts have been either too global or too limited. Approaches that identify broad, general, categories (e.g., behavior, environment) and stipulate that the interactions among these must be recognized are too vague for the present purposes (R. Kaplan, 1991).
To be useful for environmental assessment, a framework must fit somewhere between such extremes; it must provide an understanding how different environmental patterns have their diverse effects of human experience, effectiveness, and well-being.

3.7 Psychology of place

A good environmental image gives its possessor an important sense of emotional security. People can establish a harmonious relationship between themselves and the outside world. (Lynch, 1960, 1996).
As we have seen before, from the psychological aspect, friendliness and pleasantness are considered more important (including environmental quality, hedonistic undertone). If people have had negative experiences in connection with a place, they have experienced unfriendliness there, it creates anxiousness and dismay (which is unfoundedly associated only with childhood; actually the effects might have had their roots later in the life). Friendliness comes first in various studies. An unfriendly place may push away people and even groups of people.

Another factor that can influence environmental preference is familiarity (Lynch, 1960), how closely it is linked to our sense of balance (or anxiety) and well-being (Lynch, 1960, Kaplan, Kaplan 1982, 1991).

The next important factors are complexity (in the case of centres) and unity, encloseness, potential, social status, originality (environmental value added, aesthetic or also some new kind of factors) (Küller, 1973, Kaplan 1991).

New customs might connect environment symbolically to personal experience.

The most intensively used behavior places might have a different character; they can be broadly divided into sociopetal and sociofugal space. It is topophilia when the place attracts: people love this place and feel there positive feelings. Hostile space causes the fear of a place or topophobia (Tuan, 1974, Relph, 1976, Buttimer, 1993, Kaplan, 1991, Bachelard, 1957, 1999, Adams 2001).

Lewin's field theory tells that the living space where a person is staying consists of some regions and the person is constantly trying to achieve some goals. In order to achieve these goals, he must go through different regions in this environment where there might be some obstacles which may limit or restrict his movement and therefore he has to go round them, or over them or past them. And these goals may have both positive and negative valences. Outdoor space can be considered in terms of positive and negative spaces or spaces with positive or negative valences (Alexander, 1977). As well Nigel Thrift (1984, 2000) discusses the meaning of a place and the impact across the people, dividing the environment into positive and negative space (hard places).

In the environment there exist also invisible places, this is the part of space that people do not recognize (Hall, 1969, Calvino, 1979)

At any moment of time a person has to make a choice between several goals. Some of these have a negative valence for that person, which he tries to avoid, and the others have a positive valence he is aspiring after.

The choices made in any particular setting depend partly on each individual's own situation and characteristics (ego, personality, goals and values, available resources, past experiences, live stage etc.). Despite the seemingly individualistic and complex demands of human values and goals, there is an existence of an overarching hierarchy of human needs proposed originally by Maslow (1968), who identified a five-stage hierarchy of basic human needs:

- physiological needs: for warmth and comfort;
- safety and security needs;

- affiliation needs: to belong – to a community;
- esteem needs: to feel valued by others;
- self-actualisation needs: for artistic expression and fulfilment.

The most basic physiological needs must be satisfied before progress can be made to the higher-order ones; for example, self-actualisation. Environmental experience, decision making and action, are influenced by the holistic quality of the sociophysical environment, not just the spatial environment (Moore, 1991).

Environmental nonvisual qualities are mostly psychological, such as friendly and dangerous, community and privacy, sacred and profane.

However, there is a hierarchy the different needs are related to in a complex series of interlinked relationships. A good environmental image gives its possessor an important sense of emotional security. People can establish a harmonious relationship themselves and the outside world (Lynch, 1960, 1996).

Human behavior is therefore inherently situational: it is embedded in physical – and also in social, cultural and perceptual – context and settings.

Koffka (1935) distinguishes between a geographical environment (an environment as it actually is) and a behavioral environment (as an individual perceives it). Koffka thinks the behavioral environment is a determinant of human behavior. In fact, geographical environment becomes a part of behavioral environment. Although every person perceives the geographical environment differently, the behavioral environments are similar, as these are based on similar neuropsychological systems and also experience in the same place is the same.

3.8 Life span and people´s actions in environments

We continue to know far more about the spatial than the non-spatial qualities of environment, and about how the children, adults and older people conceptualize space more than how they conceptualize the other social, political, economic, and cultural aspects of the everyday environments around them. We know more about the environmental cognition of spatial relations, like cognitive or mental maps, than we do about the meanings and symbols that people ascribed to different parts of the environment over the life span (Appleyard, 1969, Moore, 1979, 1991).

Social time and its rhythms (time cycles and flow) coordinate the actions of many people.

Our emphasis on individual´s overall functioning in the environment has a clear counterpart in research on life-span development. As Spencer (1993) stresses, this perspective can enrich our attempts at integration by emphasizing the individual differences and the continuity of the individual throughout life.
We accept the dynamics of existence. The temporal life of an occurrence also plays important role in its recognition and categorization, because development, growth and change are essential parts of the life span of all matter.
On the other hand, the occurrences and the distributions they form are inherently static. In some ways these can be considered to be the facts of existence. Complexity is introduced into this picture by adding processes. Processes are responsible for chaining occurrences and their distributions into events, activities, and behaviors.

Liben (1991) suggests it would be useful to consider the extent to which environmental exploration is affected by what Hart (1981) called ”different affective potentials“ of place.
My suggestion is that we might focus more on the environmental cues that relate to the effective potential of space, and for different groups at different stages of the life cycle. Moore (1991) call for explicit research on environmental cues might be able to be related to and aided and abetted by Gibson´s (1979) concept of affordances.

Valsiner (1987) describes how the human´s world is socially constructed in the earliest years for him or her. The same point can be made for any point in the life span, especially where the individual is encountering a new setting: a new recruit, be it to school, to a new work place. On the occasion the physical environment clarifies the rules of conduct: areas are divided according to functions, signs instruct or suggest, invisible social “dividing lines” and so on.

Life stages are, in themselves, construable as an extending and changing set of behavior settings, with (until old age for some) an expansion of the range of roles in which one encounters with the world. Social forces and these developing social roles, mediate one´s encounters with the world. A life span accounts of the individual’s environmental preferences, cognitions and actions.

Baltes (1979) argues that three types of factors influence the life-span development in the landscapes: age graded, history graded and non-normative factors, which do not necessarily

occur to all people through their life course. Such nonnormative factors are particularly poor health (usually related to old age), and recent negative events.

When evaluating environments children selected different environmental characteristics in relation to specific interests, needs, or values that vary as a function of a age – preference for environments being related both to subjects: past experience and to their expectations for the future (Zube,1987, 1991). Children´s environmental assessment can be viewed as a holistic phenomenon in which cognition and emotions as well as plan and action are integrated (Hart, Conn, 1993). In adults, the behavioral goals and plans one has are the a key factor in the assessment of environment (Canter, 1993). The ability a person has throughout the lifespan to differentiate their plans for acting in environments is growing.

Lyons (1983) concludes that the development of landscape preference is a cumulative process that reflects the action through the life cycle, of socially differentiating attributes, such as age, gender, place of residence, and environmental experience.

Social and emotional development demonstrates different interests during the life span, which may account for differences in environmental preferences (Canter 1993).

According to Rachel Kaplan (1985, 1991), humans, after all, respond not only to the `things` but also their arrangement, and not merely to the arrangement, but also to the inference of what such arrangement makes possible.

Environments typically used by people and objects are purposefully arranged in space. Thus, spatial arrangement of a place is related also to memories of social or individual actions performed in a similar place. Such memories enter into the individual´s place schemata and may orient preference. It would not be surprisising that one tended to appraise places in which the spatial arrangement evokes memories linked to pleasant activities. Individual, age-related, and even cross-cultural differences in environmental preference may be attributed to differences in past experience organized in place schemata.

As spatial arrangement is an important source of information about the social activity faciliated or inhibited by a given place, spatial relations in everyday environments inform people about which actions can be performed in a given place.

3.9 Place schemata

It is useful to conceptualize schemata not only quantatively but also qualitatively. We need to know more about people´s judgements not only of location, but also of the appearence of a

place, what items are expected in different places, whether all things and all qualities (Moore, 1991) considered, a particular place is or is not a prototypical instance of that archetypical place. This way of thinking about schema can lead to fruitful research questions that can inform applications.

From Mandler´s analysis of the effects of schemata, we may ask what environmental cues lead to places being assessed as familiar, or well organized or for schema to have information. (Moore, 1991)

Axia, Peron and Baroni (1991) utilizes the concept of cognitive shemata to suggest a strong link between individuals' evaluations of places and their ability to recognize and comprehend the basic elements in a scene, their location, and their function. Given that schemata of places result from experience with both specific exemplars of place and overall knowledge of the category of place types in which a particular locus falls, a ready connection is made with the life-span perspective.

Liben´s (1991) environmental cognition provides a careful analysis of the role of several physical, social, cognitive, experiental and historical factors that may partially account for changes in environmental cognition over the life course. Among these hypothetical factors are locomotion, physical stature, self-object differentiation, attachment, negative affect, thinking skills and extent of familiarity.

Relating to the affective appraisal of the environment (Russell, 1984), place evaluation envisioned in terms of the degree to which a place is seen as helping to achieve goals (Canter, 1983, 1991), the cognitive components in environmental assessment and the "supporting environment" – that is an environment in which the information necessary for making decisions is readily available and interpretable (Kaplan,1982, 1991), preferences for places and their actractiveness (Nasar, 1983, Zube 1981), residential satisfaction and neighborhood attachment, and identification of standards of quality for various settings (Craik, 1981).

These aspects are all interrelated to the concept of place schema. A place schema is abstract and hierarchically organized knowledge about places. Perception of a place can be viewed as the mere fact of coming into contact with a setting through the senses. Perception may also include the categorization and/or the conceptualization of a place, and it can also mean to form or use place schemata. As for place evaluation, it can deal with a cognitive evaluation of a place in terms of rational, logical thinking, and evaluation of the affective/emotional aspects of place, and supportive environment. Perception is often guided by many factors, including previous knowledge about places, individual goals when coming into contact with a place, subjects attention level and mode of interaction with the place. Furthermore, to perceive a

place as ”a place“, and not merely as an array of items, requires organization into a meaningful unit.

If place schemata are abstract and hierarchically organized representations of knowledge about places, the passage from perception to categorization of places linked to schemata of places the individual already possesses or will form on that occation. Schemata can guide categorization and conceptualization of places, but are, in turn, formed or modified on the basis of new information extracted from place perception (Axia, 1991).

Knowledge of everyday life environments is considered to be organized into A scene or schemata (Mandler, 1984). Axia (1991) argued that a place schema is the knowledge resulting from having encountered various instances of that place. Axia expects also that the affective/emotional evaluation of places, including aesthetical values, should be more idiosyncratic than the cognitive evaluation of them.

Relative importance exists. Age–related differences in environmental preference have not received, more important is sociocultural adaptiveness (Baker´s environmental coding). People´s preference for places may change according to their age (Lewin, 1952, Axia, Liben, Cohen, 1991).

Settings and schemas are often evaluated with respect to the future opportunities they afford.

In conclusion, Moore´s sociophysical environment is useful to conceptualize schemata not only quantitatively but also qualitatively. We need to know more about people´s judgements not only for location, but also of the appearance of a place, what items are expected in different places, whether all things and all qualities considered, a particular place is or is not a prototypical instance of that archetypical place.

This way of thinking about schema can lead to research questions that can inform applications. For example we may ask the following questions: what are the major place identities that make up the environment? How close does a particular place have to come to the place identity to be recognized and assessed as an example of the place identity? Further, what are the salient environmental variables that inform this decision-making process; in other words, in what ways does a place have to resemble the template to be recognized? In addition, the categories of the known environment should be examined. A phenomenological orientation, for instance (Moore, 1991), might suggest asking questions about the interaction or integration of environmental knowledge and experience, whereas a structural orientation might direct one to ask questions about the underlying or deep structure behind more manifest images of the environment.

4. Methodology

Main focus of this thesis is on geography, although it covers other social sciences (sociology, psychology) and uses methods of formal information processing.

Geography itself has been undergoing a renaissance during the past decade. Geography´s focus on the study of human society and the environment through the perspectives of place, space, and scale is finding increased relevance in fields ranging from ecology to economics. At the same time, many of its research tools and non-linear analytical methods have moved from the research laboratory into mainstream of science.

The availability of large quantities of data tends to mask a broader underlying problem: geographers must also improve the practice of relating the (”front-end” of geographic analysis – conceptualization and data selection/sampling and design with back-end modelling and analysis. It is important that the capacity of geographic analysis to address issues of complex system and non-linear dynamics needs to be improved in order to fulfil geography´s potential to contribute to the body of science.
In addition, it is important to recognize the value of utilizing a variety of methodologies in seeking better understandings of the world, combining geography´s characteristic appreciation of diversity with its recognition for producing knowledge.
A particular challenge is that of analyzing and modelling relationships among natural science and human science phenomena and process, which are so often separated by boundaries of epistemology, professional specialization, data categories, and units of measurement. Besides technical challenges, such as relating economic and ecological indicators, this is also a challenge to individual scientists to transcend conventional boundaries for understandings of other kinds of processes and linkages.

Rediscovering geography also means to develop integrative, interdisciplinary, relatively large geographic research initiatives in response to priorities of science and society. The utilization of geography´s perspectives and knowledge base has increased immeasurably.
A research task in geography today is to disclose the hidden invisible reality in order to identify societal structures and actors and to find out what their effect on the development of

places is. A conclusion has been reached that scientific research of places will enable us to disclose the hidden and imperceptible structures of natural and social world. According to the structuration theory developed by the British sociologist Anthony Giddens, community development occurs as an interaction of human agency and social system. Human activity in general is constructed in social structures. The structures both enable and restrain individuals' activity. The structures are instruments of social practices, rules and resources (Giddens 1984). At the end of 1980, a broader discussion was brought up again about the concepts and psychology of the place, locality and nativity (behavior places) (Kaplan, 1991).

In this master's thesis "*Mapping of the socio-spatial organization of coastal areas of Hiiumaa and Läänemaa*" in 2000 (Juurikas, 2000) the concept of physical proximity – Euclidean distance, drawing a Voronoi diagramme for Hiiumaa (Figure 2) was used and an outcome was an associative network. It was shown that spatial associations, in my master's thesis called "Thiessen polygons", follow the stimuli arising from the environment and a dynamic model Environment (E) → Stimulus (S) → Behaviour (B) is applicable.

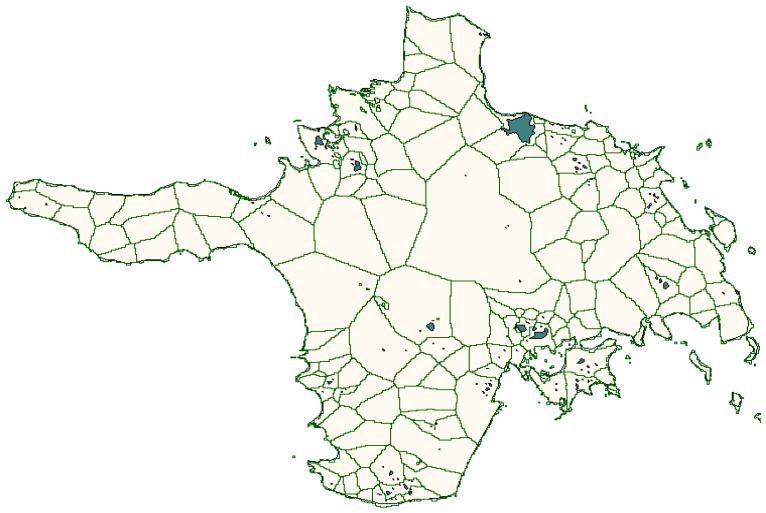


Figure 2. Voronoi diagram of the island of Hiiumaa: Eucleidian distances between the settlements.

In addition to mathematical model-based constructions, a case study of settlements was conducted, by a survey of 483 households.

As the field of this study concerns small island territories, the structure of social relations (including family and friendship) and constructs appeared on small territories, which raised the next research question of how to distinguish and map this invisible or hidden structure.

We had to find methods for information processing which lack their own internal semantics and can be used to measure non-commensurate nominal features and to identify nonlinear relations of multidimensional data. Most suitable for this, however, are the information processing methods for non-metric no-yes type data, or formal processing systems. We had a good opportunity to test the Conformity Scale and Monotone Systems techniques (the plus/minus techniques) worked out by L. Võhandu and J. Mullat (1976) at Tallinn University of Technology, Estonia, and introduced in 1976 in the article by Mullat. In the Conformity Scale and Monotone Systems one does not need to know in advance the structure of social relations – these become evident as a result of analysis and mapping as behavior places and also so-called invisible space, or that part of space that people often forget because they do not use it. Hence, self-organization of a system can be defined also with the help of new methods used in this paper to be examined next. A significant feature here is the birth of associations based on similarity (pull-force) as well as contrasting (repulsive or pushing-force) of the elements and characteristics.

As the Conformity Scale and Monotone Systems identify the cores of elements or attributes and form ontological frameworks, we decided to additionally test the Formal Concept analysis developed by Germans Wille, Ganter and Stumme, which is used increasingly more widely in the world and which, according to its name, divides attributes and elements into respective concepts.

4.1 Social networks

According to Golledge (1991), a social system determines the functioning of places.
Analysis of social networks had its origin in social sciences. Precursors of social networks in the late 1800s include Émile Durkheim and Ferdinand Tönnies. Tönnies argued that social groups can exist as personal and direct social ties that either link individuals who share values and belief (G*emeinschaft*) or impersonal, formal and instrumental social links (G*esellschaft*). Durkheim gave a non-individualistic explanation of social facts arguing that social phenomena arise when interacting individuals constitute a reality that can no longer be accounted for in terms of the properties of individual actors. In 1954 J.A. Barnes, a social

scientist, started using the term "s**ocial network analysis"** systematically to denote patterns of ties that cut across the concepts traditionally used by the public and social scientists: bounded groups and social categories. Scholars such as S.D. Berkowitz, Stephen Borgatti, Ronald Burt, Linton Freeman, Mark Granovetter, Nicholas Mullins, Anatol Rapoport, Stanley Wasserman, Barry Wellman, and Harrison White expanded the use of social networks.

This doctoral thesis is interdisciplinary, bringing together problems of human (more precisely, behavioral) geography, which is contiguous to various social science approaches adding to it formal information processing methods. The most important sphere of behavioral geography is the investigation of human spatial behavior. The main questions are: How do people use space? How do they act in space and set their objectives? Based on the above, how do people organize in space and form social networks? This last question is the most important from the aspect of setting objectives for this research. Based on research data or attributes from different categories, the purpose of this thesis is to define settlement networks created by people and forecast their development, as well as to find key attributes that determine the development of a social network.

A settlement system from the aspect of this research is a social organization which has a hierarchy. Although in classical terms social organizations are social systems where people have meaningful social interrelationships, social organizations can take many forms, depending on a social context. In this research socio-economic context is everyday life and people have no definite interrelationships, and we can see interrelationships between settlements only as a result of the analysis. Settlements in this research are social aggregates (concentrations of people that do not presume any meaningful interrelationships), on the one hand, and human behavior places, on the other hand.

Such information remains hidden both for a case study and statistics. We use also Management Functions (functions based on Monotone systems' Minus Technique) as methods of analysis, which will be used to measure **the social position of a settlement in the system.**

This is the position of a settlement in a given community and real cultural situation. Social positions a settlement may hold fall into the categories of settlement hierarchy, where one will be a central position while the rest are peripheral positions. Social systems or social structure in general refer to entities or groups in a definite relation to each other, to relatively enduring patterns of behavior and relationship within social systems, or to social institutions and norms becoming embedded into social systems in such a way that they shape the behavior of actors within those social systems. It is clearly conceptualized (Jary and Jary 1991, Abercrombie et

al. 2000). Therefore the settlement system of islands should be examined rather as a system working as a network which has a hierarchical structure.

Social network has been used as a technical concept equally in social and technical sciences. A modification of its classical definition fits into this thesis. Networks (knots) are defined on the basis of typicality developed on the basis of similarity. The value of a settlement in the network is measured by the weight of typicality.

Research in a number of academic fields has shown that social networks operate on many levels, and play a critical role in determining the way problems are solved, organizations are run, and the degree to which elements or individuals succeed in achieving their outcomes and goals.

In its simplest form, a social network is a map of all of the relevant ties between the nodes being studied. The network can also be used to determine the power and centrality of settlements as actors. These concepts are displayed in a social network scatter plot, where nodes are the points and ties are the lines.

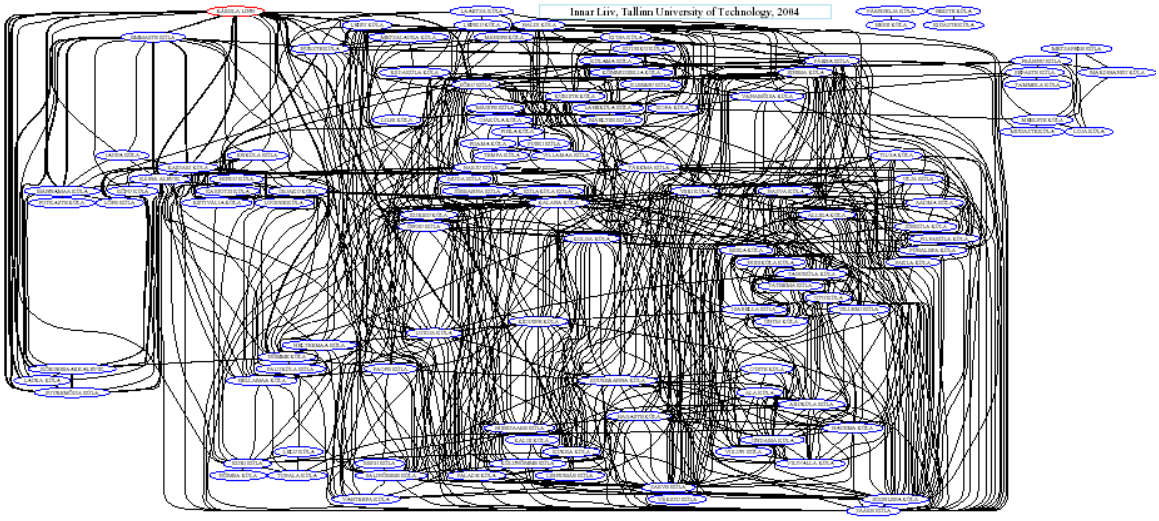


Figure 3. Social networks between the Hiiumaa´s settlements: existent networks and formation of novel structures (Innar Liiv, 2004).

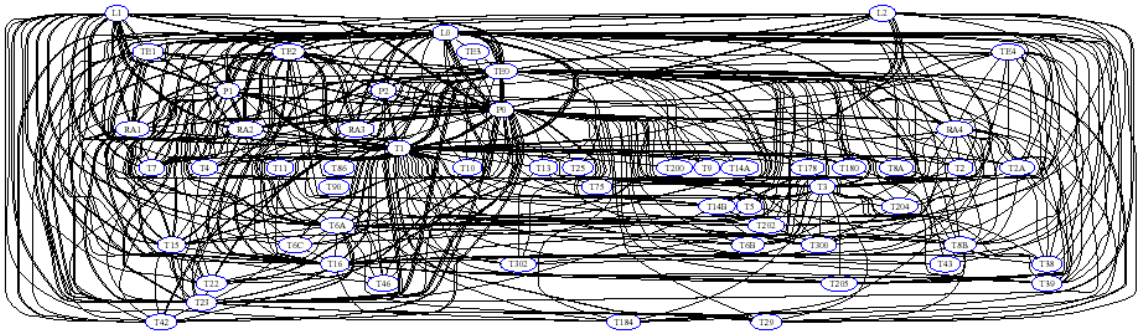


Figure 4. Attribute´s networks: Significant concept of the leisure indicators (activities) appeared (Innar Liiv, 2004).

To determine the development of settlements as social aggregates and regularity of changes we need to investigate the impact of various possible causal aspects.

For that we take a number of different geodata which belong to different categories: business and economics, intervals of economic indicators, intervals of demographic indicators, cultural and social indicators, nature reserves and individual natural objects, beaches, agricultural activity, service providers (including public sector), technical infrastructure such as airfields, ports, boat harbours, landing places etc. that can be characterized as indicators relevant to human activity.

In the space of human activity one factor is related to another. Indicators are not comparable to each other either and a relatively large amount of attributes makes it extremely difficult to use the standard statistical methods (like, e.g. regression analysis).

Moreover, we want to analyze and use multidimensional and qualitative indicators that cannot be measured with statistical analysis, and obtain adequate quantitatively expressible results.

The most suitable statistical method to create such classification might be a cluster analysis, which has been used, for example, by the cultural geographer and anthropologist Geert Hofstede for measuring cultural differences between economic regions. He also used the geographical aspect, although all attributes were equally measurable and qualitative by nature.

We prefer Formal Concept Analysis (FCA), because clustering methods group similar objects together without providing an explicit definition for clusters. Concepts in Formal Concept Analysis combine both group of objects (extent of the objects) and set of the attributes shared by those objects (intent of the concept).

However, as a social system determines the functioning of places, one of my principal objectives is to find essential attributes that determine the structure and functioning of the system in the context of a social space.

On the basis of my research, a social system is determined only by an average of 9.8% of the factors for the two islands together. On the basis of 9.8% of the attributes we can prognosticate the functioning of similar (social) organizations and model the tendencies and trends that turn up in the settlement network. These attributes are listed in Table 10, Chapter 5.

As the data, or attributes, used in the research belong to very different categories, the methodical task of this doctoral thesis is based on the principle of using new, more effective methods – *Conformity Scale*, *Monotone Systems* along with management functions and *Formal Concept Analysis* to study social space the organization of which is determined by socio-economic (population, social, economic etc), psychological (cognitive, behavioural) and physical (location of some objects) factors.

Factors themselves can also be determined with these methods.

4.2 Overview of methods

Our novel methods based on pattern (associations) recognition techniques can usually be treated as a multi-pattern classification. Two underlying problems are: (1) selecting a group of effective features (attributes) and (2) building a pattern classifier with high classification accuracy. Tools of the Monotone Systems have evolved for solving hard and different real-world problems, for example, computer language, structure of social organization etc.

The main area in this reasearch is related to social sciences, first of all to human geography and the areas bordering it. Social sciences are using many qualitative characteristics, but a large amount of such variables makes use of standard statistical methods in spatial social and economic research extremely difficult. The Conformity Scale and other methods of Monotone Systems can solve difficult high-dimensional and nonlinear problems such as feature extraction and classification of images and patterns.

Our methods require discrete data table and they are based on a computationally simple weight functions that describe object “typicality” for that data table. Use of two slightly different weight functions allows us to create two-dimensional conformity plots visualization for multivariate social-economical data. As similar elements have similar weights, it is possible to find groups of similar settlements forming socio-economic classification of the settlements.

We applied these methods to analyze socio-economic data about the functional regions, like Estonian islands of Saaremaa and Hiiumaa as target areas to show that notable outliers and typical settlements can be found with our method. The outliers are fast developing territories that we are looking for and settlements of top position.

Data in our table are binary, where meaning of some values are "existent" (one) and "missing" (zero). It is also computationally a fast method where only one pass through data table is needed. We find a weight called conformity for each object in the data table. Conformity for an object is calculated by a transformation where instead of the attributes value we use its frequency (so-called frequency transformation) (Võhandu, 1979, 1989). Most of the attributes are binary by nature such as physical existence of a port or a school and carry the cognitive character. Each numerical attribute was replaced by several attributes that represent an interval. For example, the number of children in a village is represented by four binary attributes: children <10, children 10-50, children 50-100, children >100 etc.

Large amounts of different kinds of variables make the use of standard statistical methods extremely difficult in spatial economic research.

4.2.1 Monotone systems

The following techniques of Monotone Systems are presented:

- *Conformity Scale;*
- *Technique of Minus;*
- *Technique of Plus;*

and their combined functions.

In the C*onformity Scale* we find a weight called conformity for each object in the data table. Conformity for an object is calculated by a transformation where instead of the attributes value we use its frequency in the data table. This is the presumption to use the Monotone methods as techniques of minus and plus, etc. But it also works successfully as an independent method.

Minus Technique starts eliminating from the system elements that have the smallest weight or most untypical elements for the system – in this case these are settlements in rows and activities in columns. The last one(s) singled out is the most typical element or the system.

Plus Technique conducts the opposite process to the minus technique. The most typical elements, or those which have the smallest weight, will be eliminated from the system first and the last will be the most untypical elements.

In the minus and plus techniques, we additionally use the management algorithms, which makes it convenient to identify the social organization's structure independent of the outward (visible) hierarchy.

Our data are binary. Most attributes are binary by nature such as existence of a port or of a school. Each numerical attribute was replaced by several attributes that represent an interval. If a given element does not have commensurate attribute the value will be automatically fixed as zero. A fragment of our data table can be seen in Table 1.

Tabel 1. Fragment of the discrete data table

Town/village	Children under10	Children10-50	Children 50-100	Children over 100	Children existing
	L1	L2	L3	L4	L0
KÄRDLA				1	1
EMMASTE			1		1
HALDI	1				1
HALDREKA					
HARJU		1			1
HINDU		1			1
HÄRMA					
JAUSA		1			1
KABUNA					
KADERNA					

To create an order in practically any data table we are using an effective method – the method of Monotone Systems. It is a very general and simple method.

Table 2. Fragment of the matrix database

Town/village	Children under 10	Children 10-50	Children 50-100	Children over100	Children existing	Work age up to 10	
	L1	L2	L3	L4	L0	TE1	
KÄRDLA	0	0	0	1	1	0	32
EMMASTE	0	0	1	0	1	0	32
HALDI	1	0	0	0	1	0	32
HALDREKA	0	0	0	0	0	1	30
HARJU	0	1	0	0	1	0	36
HINDU	0	1	0	0	1	0	36
HÄRMA	0	0	0	0	0	1	31
JAUSA	0	1	0	0	1	0	36

To find a structure in the data a Monotone System is to be created on the data and data are to be reordered in their order at elimination. It is quite easy to be performed:

1. Every object (settlements here) has to acquire a measure (social value, economic value, etc), shown in Table 2.
2. The measure has satisfy the following: if there is a change in the measure of one object in the system, the measures of other objects has to change in the same direction or stay on the same level. (That will guarantee weak monotonicity in the mathematical sense).

3. Find the weakest object and eliminate it. If there are leftovers, recalculate the measures and go to step 3, otherwise stop.

For nominal data a useful measure to acquire a monotone system is just to change every variable´s value with its frequency in the data table and sum those together.

That measure is a conformity measure or so-called weight. The highest weight designates the most conformal object(s) in the group. The lowest sum shows us the weakest object in the group behavior. So we act as a directors using the minus-technique. We just eliminate at every step the weakest object in the system and recalculate conformity measures of objects.

It is an easy task, especially with a computer and finally we acquire a reordering of data in the table. We repeat the same process also for the columns of the table.

In the Estonian islands environment only few activities conducted have economic significance and the same is with the settlements - most of the functions/indicators have been realized (occur) once or twice/three times in major settlements or in some intermediate village with small-size industry; and only demographic indicators are common for a significant amount of villages. Villages in the islands have been divided roughly into two groups: monofunctional places (housing places) and multifunctional or central places. Most of the villages (3/4) are just for residential purposes. Specific activities and attributes occur in the largest settlements, which already have a number of activities and other attributes. Because of this we use of two slightly different weight functions, which allow us to create novel two-dimensional conformity plots visualization for multivariate socio-economic data. As similar elements have similar weights, it is possible to find socio-economic groups or clusters of similar settlements.

A comparison of function values on the scatterplot points out all possible linkages based on whether the ”events“ take place (existence of an indicator) or not; and in these conditions the associations are formed of points (settlements) with the same or similar attributes. For instance, major settlements have been separated from the main group because of the multitude of activity indicators (small number of zeros). It is important also that ”events“ do not take place there because of a multitude of zeros in most of the places.

4.2.2 Conformity Scale

We describe here in more exact and formal terms the Conformity Scale approach that is one of the simplest Monotone Systems methods. It is also a computationally fast method where only one pass through a data table is needed. We find a weight called conformity for each object in the data table. Conformity for an object is calculated by a transformation where instead of the attributes value we use its frequency (so-called frequency transformation). For every row in the data table we calculate the sum of all attribute-value frequencies. This sum is the conformity weight for that row. Intuitively conformity describes object "typicality" for the entire data table (system). If we include frequencies of missing and negative values (zeros in a binary data table) in our conformity calculation, then we are using weight function π_{01}. If we do not include frequencies of zero values (we are using only frequencies of ones in a binary data table) in the weight calculation, then we are using weight function π_1.

Formally computing conformity weights are:

$\pi 01(j) = \sum i=0..N\ f(i, Aij)$

and

$\pi 1(j) = \sum i=0..N\ g(i, Aij)$, **where**

$g(i, Aij) = f(i, Aij)$, **if** $Aij > 0$

$g(i, Aij) = 0$, **if** $Aij = 0$,

where,

i - column index

j -: row index

f(i, Aij)- frequency for the value Aij in column i

$\pi 01(j)$- *weight for the object* j

$\pi 1(j)$ *: weight forthe object* j

For example, let us consider the following data table:

Table 3. j * i binary data table

j / i	1	2	3	4	5	6
1	0	0	0	0	1	0
2	0	0	1	1	1	0
3	1	0	0	0	1	0
4	0	0	0	1	0	1
5	0	1	0	0	1	0
6	0	1	0	0	1	0
7	0	0	0	0	0	1
8	0	1	0	0	1	0

After calculating frequencies and weights we obtain:

Table 4. Weights and frequencies for Table 3, rows are sorted after π_{01}

j / i	1	2	3	4	5	6	$\pi_{01}(j)$	$\pi_1(j)$
1	0	0	0	0	1	0	37	6
5	0	1	0	0	1	0	35	9
6	0	1	0	0	1	0	35	9
8	0	1	0	0	1	0	35	9
3	1	0	0	0	1	0	31	7
7	0	0	0	0	0	1	29	2
2	0	0	1	1	1	0	27	9
4	0	0	0	1	0	1	25	4
f (i, 0)	7	5	7	6	2	6		
f (i, 1)	1	3	1	2	6	2		

Such ordering of a data table makes it possible to detect frequent itemsets[3] visually from the data table. For example, an itemset {i3=0; i4=0; i5=1; i6=0} with support 5 is clearly visible from our sorted table.

Data table about Hiiumaa is very sparse – only 4.7% of values are ones. When using weight function π_{01} on the sparse data table, mostly empty rows tend to have the highest weights.

It is reasonable to use both weight functions - π_{01} and π_1 - for data mining and visualization.

This method can be used for any discrete data table regardless of the number of attributes (dimensions of factors). Our proposed conformity plot visualization is similar to clustering visualizations like Kohonen nets and nonlinear projection visualizations like Sammon plots (Hoffman and Grinstein, 2002). Our visualization displays clusters and outliers. Furthermore:

[3] Here we are using some simple notions from the data mining theory: Itemset is a given subset of all variables having given values to support the count of the set.

both axes in our visualization have intuitive meaning, as they show objects typicality for a data table. Most typical objects are located in the upper right corner of the plot.

4.2.2.1 Internal structure of the concepts on the conformity scale

We noticed that the main group has its own internal structure and the points (settlements) are placed on the chart according to some rules, which also describes the possible development path of that settlement.
In this section we will show the content side of the structure of the main group from the aspect of settlement research.
By increasing "the main series" in the settlements' scale of the conformity chart, we can see diagonal stripes (Figure 12). A common denominator of the settlements in the "stripes" is the number of true values of the attributes. Beneath the stripe of settlements with ten true values there is a stripe of settlements with nine true values, and beneath it a stripe of settlements with eight true values etc. This is a mathematical attribute of weight functions π_1 and π_{01} in the binary tables, which we will verify next.

Theorem: Let us have a row j of a binary table A. Let us change the data table A by taking element A_{aj}, which previously was equal to one, and replace it by zero, and by taking element A_{bj}, which previously was equal to zero, and replace it by one. More simply expressed, let us move in row j any value of one from one column to another. Denote this new data table by A' and row j weights in this table by $\pi'_{01}(j)$ and $\pi'_1(j)$. In that case:

$$\pi'_{01}(j) - \pi_{01}(j) = 2 \cdot (\pi'_1(j) - \pi_1(j))$$

or by relocating one true value, the change in weight π_{01} is equal to two-fold change in weight π_1.

Proof:
In the original data table we have
$\pi_1(j) = C + f(a, 1)$,
where C is the sum of frequencies corresponding to the columns of ones except for a.

In the transformed data table

$\pi'_1(j) = C + f(b, 1)$

$(\pi'_1(j) - \pi_1(j)) = f(b, 1) - f(a, 1)$

Similarly, for π_{01} measure

$\pi_{01}(j) = K + f(a, 1) + f(b, 0)$,

where K is the sum of frequencies corresponding to the columns of ones except for a and the columns of zeros except for b

$\pi'_{01}(j) = K + f(a, 0) + f(b, 1)$

$(\pi'_{01}(j) - \pi_1(j)) = f(b, 1) + f(a, 0) - f(a, 1) - f(b, 0)$

As each column i has frequency $f(i, 0) = M - f(i, 1)$ (M is the number of rows) then:

$(\pi'_{01}(j) - \pi_1(j)) = f(b, 1) + M - f(a, 1) - f(a, 1) - M + f(b, 1)$

$(\pi'_{01}(j) - \pi_1(j)) = 2 \cdot (f(b, 1) - f(a, 1))$

$(\pi'_{01}(j) - \pi_1(j)) = 2 \cdot (\pi'_1(j) - \pi_1(j))$

qed.

The rows of points or “stripes” (Tables 3 and 4, example in subsection 4.2.2) have a meaning in both ways from left to right and from top to bottom: the number of attributes in the stripe is growing, and so does the number of common attributes in the stripe: when the indicators of parallel points are different in some places, then points from top to bottom have exactly the same attributes, but the lower points have a larger number of indicators. The vertical rows also show from left to right the amount of coinciding point attributes, which is the smallest on the left margin and biggest on the right margin. A reason is that the settlements on the left margin have less attributes and hence also less possible coinciding attributes. The typical, right margin villages are linked by a number of wide-spread indicators – possible coincidences are more numerous.

4.2.3 Management functions

This section considers the problem of analysis and improvement of settlements organizational structure, using the method of Monotone Systems (Plus and Minus Techniques) to identify the structure of the Management Function distribution matrix. Sufficient conditions for rational change of these matrices are given. The analysis of organizational structure and application of the conceptual approach to the structure of organizations are described.

The data in the table are reordered in their elimination order. After that we follow the conformity values of objects at the moment of elimination (last column and last row) from the end to the start up to the local extrema. We can see that objects make up quite homogeneous patterns on certain variables. Naturally with some exceptions we have to do more study to explain what the reasons of differences are.
We have quite large data tables for Hiiumaa and Saaremaa and this kind of a simple process gives us a powerful method to study objects and their variable value patterns.

We use also the algorithms worked out by Russian scientists I.B. Muchnik and E.N. Kuznetsov (1982) on the basis of Monotone Systems (Plus and Minus Techniques), so-called management functions, and thereby obtain the hierarchical system of our social network. This algorithm was initially invented to identify the organization's (enterprise's) structure independent of the outward (visible) hierarchy. It is an analysis of the actual structure of an organization that is applied in two ways, two different management functions are used:
(1) Administrative activeness is measured by a weight function, where the weight is assigned according to such functions that are not represented in other settlements.
(2) Competence/incompetence function assigns the weight to the settlement by subtracting the number of functions that are performed by the settlement from the overall functions that are performed by settlements in general.
The former technically adheres to the Minus Technique principle where the least weighty elements are eliminated from the system first and the most active ones (which have more activities and tasks) last.
The latter function works on the basis of the Plus Technique – the most competent ones are eliminated from the system first.

Minus Technique starts eliminating from the system elements that have the smallest weight or are the most untypical elements for the system – in this case these are settlements in rows and activities in columns. The last one(s) singled out is the most typical element or the system.
Plus Technique conducts the opposite process to the minus technique. The most typical elements, or those which have the highest weight, will be eliminated from the system first and the last will be the most untypical elements.

These are called Management Functions since Kuznetsov and Muchnik (1982) were the first to analyze an enterprise as a social organization with this method and to identify its hidden structure and growing entities.
Roger Barker observed already in 1968 while working out the behavior place theory that the stage of a behavior place depends on its functioning. Much earlier and independent of Kuznetsov's and Muchnik's Management Functions theory, he stated that a behavior place may often fulfil the role of a leader, of an active functionary or coordinator, of a worker or a bystander.
Behavior places are characterized by an organized structure and mostly its components (people) and collection of things are hierarchically positioned. Different levels can be distinguished depending on the degree of impact of the actors.
On each level particular behavior is required or particular behavior is expected from persons. Each behavior place needs a particular amount of components and diversity of these components. Baker is of the opinion that the behavior places are hierarchically located. Physical environment and a person are not directly related, but their relationship is realized through a metasystem. Dependence of behaviour on a behavior place does not require knowledge of the whole behavior place. People also carry out only part of their possible behavior place programme.
Barker not only studied the elements of behavior places or people, but also classified the behavior places.
These theories are covered in this thesis (in section 5.3).

4.3 Formal Concepts

Formal Concept Analysis (FCA) was developed by German scientists Wille, Canter and Stumme in the middle of the 1980s. During the last 20 years this method has grown into an international research community with applications in many disciplines, such as linguistics, sociology (Freeman, White, 1993), psychology (Spangenberg and Wolff, 1993, Wolff, 2004), software engineering and machine learning (Kuznetsov, 2004), artifical intelligence, and information retrieval knowledge discovery and data mining (Valtchev, Missaoui, Godin, 2004).

One can argue that ”formal concepts“, as defined in FCA, describe a natural feature of information representations that is fundamental to hierarchies and object/attribute structures as the set theory or relational algebra is to relational databases. The reason for this claim is that the basic structures of FCA have been discovered over and over by different researchers and in different settings. Formal concepts development is due to a variety of factors. Freeman and White´s (1993) paper on Social Network Analysis sparked interest in the use of FCA software among social scientists. However, R.Haralik did use mathematically isomorphic theory already in 1974 (so-called dicliques).

Formal Concepts Analysis provides a contrast to some of the traditional, statistical means of data analysis and knowledge representations because of its focus on human-centered approaches.

4.3.1 Formal Concepts ontology

Ontology is the study of existence. An ontology is a system of categories for classifying and describing the things that are assumed to exist (Sowa, 2000).

The present section attempts to clarify issues relating to the semantic integration of geographic ontologies and set the principal directions for performing different integration tasks. Existing integration approaches are evaluated on the basis of the ontological framework (Kokla, Kavouras 2005, Kavouras 2005, Kokla 2006).

Ontology integration is concerned with existing ontologies. Since knowledge evolves and new knowledge is created, so do the associated ontologies. It is therefore of utmost importance to provide tools for associating present and future ontologies when evolution occurs.

In the philosophical tradition, ontology exists a priori to perception, knowledge or language. It is sometimes further divided in reality-based and epistemological ontology; the latter describes human conceptualization of reality (Smith, 1999). A commonly used definition of ontology in the computer science community was established by Thomas Gruber (1993); "ontology is an explicit specification of a conceptualization".
Ontological approaches have been accepted as very promising (if not the only) approach to semantic interoperability.
Ontology is defined as a representational vocabulary for a shared domain of discourse. Formally represented knowledge is based on conceptualizations, which consist of objects and relationships that hold between them (Ram, Khatri, Zhang and Zeng, 2001).

Integration approaches may and usually do differ considerably due to a number of reasons.
One reason is that approaches may rely on different semantic elements, either because these are simply the only ones available or because these are considered semantically more important or reliable than others. Most approaches to ontology integration (Calvanese, et al., 2001) just rely on term similarity to express mappings between concepts. This proves to be simple but not always an effective mechanism; other approaches incorporate additional descriptive information, such as attributes and parts or subsumption relations among concepts in existing schemata or hierarchies. Another reason is the context of comparison. Ontologies and their concepts have been developed according to different thematic domains.
How can such semantic information be derived from existing sources in existing approaches – intuitive or direct mapping based on "deep" semantics? Similarly to the semantic correspondences by Wache et al. (2001), the objective of this direction is to avoid indirect mapping of semantic information extraction via top-level ontology, based on structural similarity, and concept/ontology comparison subjective direct mapping based on "shallow" semantic information conforming to a single global ontology (Kokla 2006). In this family of approaches in order to support direct mapping among concepts based on "deeper" semantics (e.g semantic relations) it is essential that such information is derived from the available sources.
It is apparent that the term ontology has been used recently more often in the context of geoinformatics (Frank, 1997, Bittner, Winter, 1999, Winter, 2000).
Such a progress, however, in addition to solving the intended problems has to resolve confusion caused by the different approaches developed by an interdisciplinary community for a variety of problems and domains.

4.3.2 Formal Concept ontology in geographic information systems

This section focuses on the specific problem of the semantic heterogeneity in multi-scale and multi-context regional databases.
Effective communication and smooth interaction between different sources of geodata require a method for sharing and integrating different ontologies (concepts). This section proposes a methodology for information organization and semantic integration, in order to provide reuse of data between heterogeneous geographic information systems.
The methodology is founded on the Formal Concept Analysis, a theory of concept formation and conceptual classification. The integration of multiple geospatial categorizations, which exhibit differences in spatial and thematic resolution, allows the creation of an ontology for the geospatial domain. Furthermore, the methodology and the integration process can be utilized to build a multi-scale, multi-context database from different geographic categorizations, which represents information at different levels of detail and different application context.

Raubal (2001) models an agent—based system to simulate wayfinding in environments. He needs an ontological grounding of his model to guarantee that the agent's behavior is modeled as cognitively plausible; the groundings are provided by interviews. Applying also the specific approach of ecological psychology (Barker, 1968, Gibson, 1979), Raubal distinguishes medium substances, and surfaces in the real world – his ontological part of the model-, and physical, socio-institutional, and mental affordances – his epistemological part of the model (Bittner, Winter, 1999, Winter 2000).

Frank (2000) investigates levels of ontology, which allows him to clarify different types of consistency constraints to geographical data. Distinguishing reality, observation of reality, categorization into objects and properties, social reality, and subjective knowledge (Frank, 2000), types of consistency constraints for geographic data can be separated relating to these levels. Besides clarification, it allows the integration of consistency constraints into ontological models.

Kokla and Kavouras use ontology for fusing different geographic data sets. Different data sets represent different conceptualizations of geographic space. Their approach, based on Formal Concept Analysis (Wille, et.al., 2005), yields formal descriptions of the concepts and their

fusion in a concept lattice. This is relevant for the communication between systems (Bittner, Winter, 1999, Winter 2000).

Objectives and guiding principles for building geographic ontologies is to find structure and existent ontologies (e.g. relation to top-level ontologies)
Interoperability aims at the development of mechanisms to resolve any incompatibility and heterogeneity and to ensure access to data from multiple sources. The dynamic interaction of different applications requires not only the technical support for the exchange of data, but the preservation of the underlying semantics as well.
Sharing geospatial data is difficult due to diverse conceptual schemata and semantics. The main causes of semantic (incl. cognitive) heterogeneity are the differences in the conceptualization of geographic data in conjunction with their complexity. Different geographic categorizations (differences in application context and levels of detail) pose a semantic problem when geospatial applications have to be integrated. In order to achieve semantic interoperability between different geospatial applications, a commonly accepted theory for the formal definition and representation of the semantics of geospatial knowledge would be ideal to analyse our data. This theory would provide the basis for the formal representation of geographic entities with regard to their structure and semantics.
Ontology (Guarino, 1998, Smith, 1998, Sowa, 2000), as studied by both philosophy and community, is considered an important contribution towards the achievement of interoperability. Philosophically, ontology is defined as the study of the categories of things that exists or may exist in some domain. For the community, the notion of Formal Ontology is used to note a collection of concept and relation types specified by axioms or definitions stated in a formal language and organized by the type-subtype relation. For the geographic domain, ontologies play an important role in defining the semantics of geographic information and facilitating information integration between different data (even different databases).
The methodology presented in this paper focuses on the formalization of geospatial concepts and relationships using Formal Concept Analysis (Wille, 1992, Ganter and Wille, 1999) and the integration of multiple geographic categorizations, which exhibit differences in application context and thematic resolution. These objectives facilitate geographic information sharing between different organizations and for different purposes (Kokla, Kavouras, 2005).

The integration of different existing categorizations provides a flexible and effective means to build a multi-scale, multi-context database. The integration can proceed both to the vertical and horizontal direction, which refer to different levels of detail and different application context. Thus the integration methodology can be used in model generalization, in order to provide the means to move along different levels of detail and intelligently change scale, but also move across different contexts and perform a change in the perception of geographic information.

The integrated Concept Lattice links similar classes of different levels of detail, and thus serves as a guide for the determination of the appropriate schema for specific scale and context.

Concept Lattices are used to formalize geospatial concepts and relationships and generate a single integrated structure from different categorizations, in order to reveal their association and interaction. Concept Lattices are rich structures, since they allow the existence of overlapping relationships between formal concepts. Furthermore, Formal Concept Analysis helps to detect possible implications between final classes, which are not pre-defined, as well as to reveal hierarchical relationships, which were not initially obvious (Kokla, Kavouras, 2005).

4.3.3 Formal Concept Analysis

Today Formal Concept Analysis (FCA) is a powerful tool for conceptual modeling and knowledge discovery in the world. A detailed exposition about FCA is given in ”Formal Concept Analysis; Mathematical Foundation” by Ganter and Wille (1999) or ”Formal Concept Analysis: Foundations. Applications” by Wille, Stumme and Ganter (2005). Formal Concepts in FCA can be seen as the mathematical formalization of what has been called the ”classical theory of formal concepts“. Concepts in the formal concept analysis combine both a group of objects (extent of the objects) and set of the attributes shared by those objects (intent of the concept). We prefer FCA, because classical clustering methods (K-means clustering) group similar objects together without providing explicit definition for clusters.

The formal concept analysis is based on the ability of heterogeneous information and ontological integration conceptually. Interoperability of FCA is usually defined as the ability of heterogeneous information systems to communicate, and interpret the information exchanged.

The present thesis (a) analyzes and compares existing integration approaches through the adoption of an ontological framework, and (b) performs semantic integration of geographic ontologies about empirical research in real cases in Estonian islands of the Baltic Sea.

Chapter 5. Case studies in Estonian islands

Environments are organized structurally (Golledge, 1991).
Settlements on Estonian islands are traditionally concentrated, i.e. houses are located and people live in direct vicinity. So-called village centrality has been important. Also, among newcomers there are only a few exceptions – those who settle for a vacation privately, away from settlements. Small settlements are in this study are handled as behavior places. Villages of islands are too small as units to discuss also the internal behavior of places there.

We will try to classify villages based on their similarity and typicality among other settlements.
First, we find a weight called conformity for each element (settlement) in a data table. Conformity for an element is calculated by a transformation where instead of the attributes value we use its frequency (so-called frequency transformation). For every row in the data table we calculate the sum of all attribute-value frequencies. This sum is the conformity weight for that row. Intuitively conformity describes objects "typicality" for the entire data table (system). In the same way we will analyze the attributes of Saaremaa and Hiiumaa.
Next, we will test if Monotone Systems and Lattice-based Analyses (FCA) identify the same concepts.
Settlements organizational and hidden structures and nested hierarchy will be improved to use the methods of Monotone Systems and the Management Functions distribution matrices. Two different management functions are used, based on the Techniques of Minus and Plus.

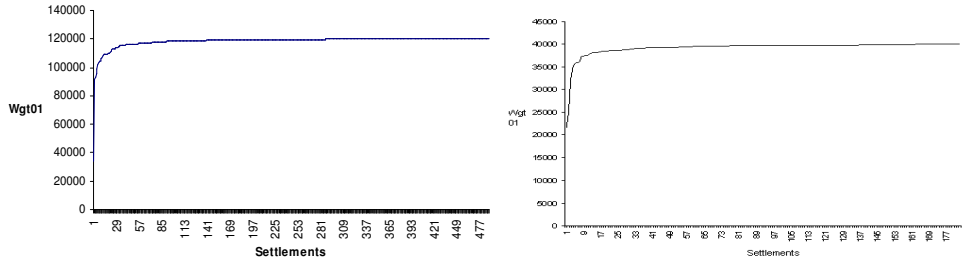
5.1 Data analysis using Conformity Scale

Two different weight functions are used here: (1) π_{01} – the function representing a whole system (subsection 5.1.1); (2) π_1 – the function representing an activities system (subsection 5.1.2). First, we calculate both for ones and zeros and then only for ones, eventually we combine both weight functions in the same scatterplot (subsection 5.1.3).

5.1.1 Whole system analysis using weight-function π_{01}.

If we include frequencies of the missing and negative values (zeros in the binary data table) in our conformity calculation, then we are using the weight function π_{01}.

In most of the settlements no economic activities are conducted, only demographic characteristics. It shows that people just live there. The data table is almost empty. Frequent appearance of zeros determines weights of the elements. Villages which have few variables with value 1, have greater π_{01} weight. Islands in our study have mostly that kind of settlements.



a. Saaremaa b.Hiiumaa

Figure 5. Settlements distribution on the conformity scale of the whole system. Settlements and their weights π_{01} sorted in ascending order.

According to the weight function π_{01}, most typical are resident villages[4]. The greatest weight in the scale of conformity belongs to 87 resident villages in Saaremaa (e.g., Levala, Saue-Putla, Väljaküla, Undimäe, Lööne etc., weight 120611) and ten resident villages in Hiiumaa (e.g., Laaritsa, Lepiku, Ulja, Aadma, Jõeküla, Ühtri, Otste, Kalgi, Pilpaküla, and Sakla, weight 40029). They are the most typical elements for the system and they have also identical demographic and social variables that are most widespread in this county.

Seven of them can be regarded as satellite villages of major settlements or urbanized housing space, which in functional terms as well as physically are related to a larger settlement. The respective rows for these villages in the data table are identical. Similar social indicators which, as we can see later, are most widespread in island villages: children, working-age people as well as retired people are represented; the population of these villages is between 10

[4] Housing space

and 50, including children and retired people up to ten and working-age people from 10 to 50. These villages have no other indicators.

We can see from Figures 5 (a., b.) that a small number of settlements have notably lower weights than others (<115000 and 36000). These are large settlements and administrative centers. They have economic activities, administrative importance and better social characteristics (more habitants, more children etc.). Their lower weights are caused by having many characteristics that are typical for more common, smaller settlements. So we can see that the scale of conformity has detected both typical elements and outliers.

In Figure 5, graphs a and b show a large amount of elements with a great weight (>115000 and >36000, respectively) and approximately 40 settlements in Saaremaa and approximately 10 in Hiiumaa have (due to the presence of ones characterizing economic indicators) much lower weight than the others but, on the other hand, greater economic and administrative importance and better social indicators (larger population, more children). Hence, the most untypical in terms of the system were the largest, most central and/or functional settlements with the capital of Saaremaa, Kuressaare at the top (weight 33693), followed by Orissaare (91503), Nasva (93083), Kärla (95803), and Valjala (99091). This group is followed by another group of central settlements, but their weight is much greater (the weight of Liiva village after Valjala is 101917 already).

The central places in Hiiumaa had very small differences in weight: Kärdla (weight 21659) and Käina (24733) formed a separate duo of central places to demonstrate that Kärdla is not a much stronger centre than Käina; the subsequent ones starting from Emmaste (32221) and Kõrgessaare (34849) had not much greater weight differences from the others either, although the position of Emmaste, as we will see later both on the combined Figure 10 (b) and with the help of management functions, is strong and conspicuous in the settlement system (although physically it is a very small settlement with a population of ca 350).

More interesting settlements sorted in ascending order by weight π_{01} are produced in Table 5.

Table 5. The most interesting settlements according to the weight function π_{01}

Settlement/ place	π_{01}	**Existing attributes**	**Comment**
Hiiumaa			
KÄRDLA town	21659	109	Capital of county
KÄINA township	24733	91	Center of community
EMMASTE	32221	49	Center of community
KÕRGESSAARE township	34849	34	Center of community
KASSARI	35795	30	Supporting settlement for center of community
NÕMME	35947	30	Supporting settlements for center of community

MÄNNAMAA	36017	27	Hinterland center
38 settlements	...	...	...
NÕMMERGA	39375	0	Places without attributes.
SÜLLUSTE	39375	0	
TIHARU	39375	0	
VIITASOO	39375	0	
LEERIMETSA	39375	0	
110 settlements	...	...	...
VIIRI	39971	9	Dichotomised villages: housing and vacationers places: retired people 1- 10, children 1- 10, working-aged adults 1-10, total population 10 - 50, summerhouses and vacationers
HAGASTE	39971	9	
KUUSIKU	40005	8	Housing places: retired 1- 10, children 1- 10, adults 1-10, total population 10 - 50
KÕMMUSSELJA	40005	8	
KLEEMU	40005	8	
LAHEKÜLA	40005	8	
MÄELTSE	40005	8	
PÄRNSELJA	40005	8	
HEIGI	40005	8	
HEISTE	40005	8	
KIDASTE	40005	8	
LILBI	40005	8	
POAMA	40005	8	
LAARTSA	40029	8	Housing places: retired people 1- 10, children 1- 10, working-aged adults 10-50, total population 10 - 50
LEPIKU	40029	8	
ULJA	40029	8	
AADMA	40029	8	
JÕEKÜLA	40029	8	
ÜHTRI	40029	8	
OTSTE	40029	8	
KALGI	40029	8	
PILPAKÜLA	40029	8	
SAKLA	40029	8	
Saaremaa			
The most non-typical places			
KURESSAARE LINN	33693		Capital of county
ORISSAARE	91503		Center of community
NASVA	93083		Supporting center of county capital
KÄRLA	95803		Center of community
VALJALA	99091		Center of community
Non-typical places			
LIIVA	101917		Center of community
KUDJAPE	103549		Supporting center of county capital
TORNIMÄE	104133		
KIHELKONNA	104687		Center of community
SALME	105799		Center of community
LÜMANDA	106889		Center of community
PIHTLA	108533		Center of community
SUURE-ROOTSI	108775		Supporting center of county capital, center of community and port
VEERE	109051		port
EIKLA	109285		Supporting settlement for center of community
KARJA	109337		Supporting settlement for center of community
MUSTJALA	109515		Center of community
SIKASSAARE	109813		Supporting center of county capital
SAIKLA	109865		Supporting settlement for center of community
Non-typical, second-rate central places			
LEISI	110063		Center of community
RUHNU	110485		Standalone island and center of community
ASTE township	111911		Supporting center of county capital
PÄDASTE	112499		Manor house, accommodation and tourism center
PÄRSAMA	112807		Supporting settlement for center of community
PIIRI	112869		Supporting settlement for center of community
TAGAVERE	112915		Supporting settlement for center of community
KAILUKA	113355		Supporting settlement for center of community
LÄÄTSA	113599		Supporting settlement for center of community

SANDLA	113771		Supporting settlement for center of community
TÕNIJA	113849		Supporting settlement for center of community
VIKI	114971		Supporting settlement for center of community
KOGUVA	115081		Museum village, accommodation and tourism center
KÄO	115105		Supporting settlement for center of community
Non-typical, third-rate central places			
ASUKÜLA	115119		Housing place, 50-100 inhabitants, 10-50 children, no services, agribusines enterprise (farming), turnover > 1M
LAIMJALA	115165		Center of community
KAALI	115239		Catering and tourism center, economic village with timber enterprise
ABRUKA	115243		Standalone island, port, warf, farming, etc
MÄNDJALA	115563		Supporting center of county capital, popular beach and resort center
KOIKLA	115587		Small hinterland center
Interesting (typical) places in the main group			
PAIMALA … IRUSTE, 16 settlements	119041		DECIDING villages: villages with until 10 working-aged adults
TAGARANNA … TAGAMÕISA, 6 settlements	119373		VACATION VILLAGES: Villages with very small local population, until 10 local inhabitants (as working-aged as retired people), NO CHILDREN. SUMMERHOUSES and VACATIONERS
JOOTME... RÄIMASTE, 6 settlements	119407		YOUTH VILLAGES, children 10 and until 10 working-aged adults, there is not old people.
TÕRU … VÄKRA, 24 settlements	119687		DECIDING housing villages, with total population until 10 inhabitants, NO CHILDREN, no vacationers
The most typical places			
23 settlements, Aula-Vintri … Vilidu	120405		Unified with the same population indicators, children until 10 , working-aged adults until 10, retired people until 10, total population 10-50 inhabitants.
87 settlements, Anijala … Väljaküla	120611		Many deciding villages: similar with the last group: just demographic indicators variable, in this group belongs to villages with children until 10 and villages with NO CHILDREN, representing as working-aged adults as retired people, total population until 50 inhabitants, (no vacationers)

To sum up, the ranking by π_{01} gives a picture where the most typical settlements are small, with a population of 10-50 and up to 10 children and no economic activity. These are residential places, because summer houses in these villages were not mentioned in interviews conducted with the rural municipality governments either.

Spectacularly untypical are large administrative centres. Central places of the second and third grade are potential developers.

Kuressaare is an exception with the strongest position in Saaremaa; it has the firmly established role of a principal centre on the island and its sphere of influence might be even stronger than that of the county centre. Strong polarization is taking place between the town of Kuressaare and the rest of Saaremaa. Also, the next centres by position are supporting centres for Kuressaare, which are adjoining to it. The capital of Hiiumaa, Kärdla, is differentiated from the general settlement system together with the second largest settlement in Hiiumaa, Käina, and does not have a very strong position.

As the π_{01} system depicts a whole, activities are few in the whole picture and we presume the local everyday activity and social network can be identified here. Figure 6 depicts the most

typical places in the whole system of islands. Figure 7 adds the exceptions, which are central places. Figure 7 shows everyday life on the islands and local social networks.

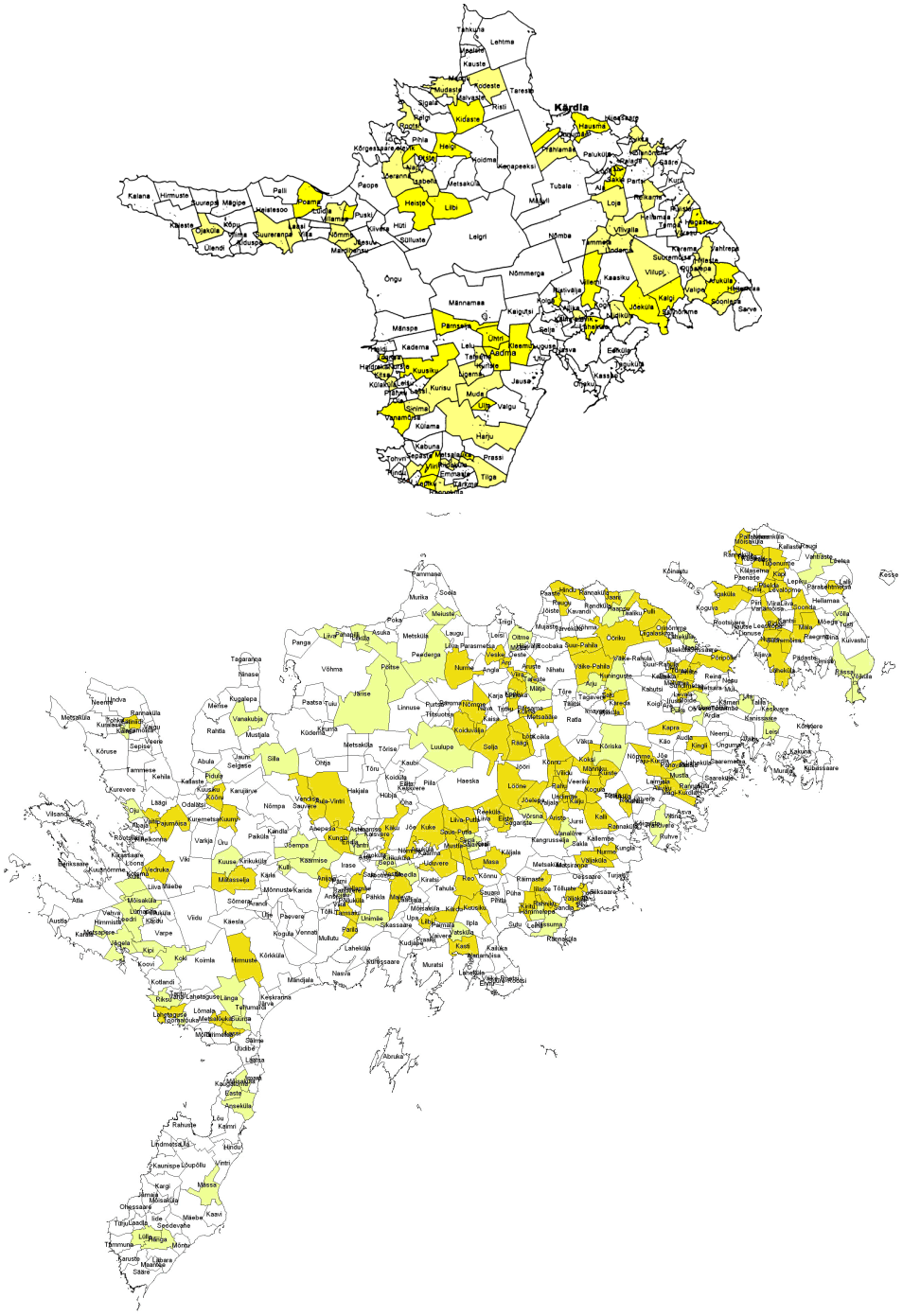


Figure 6. The most typical places in the whole system.

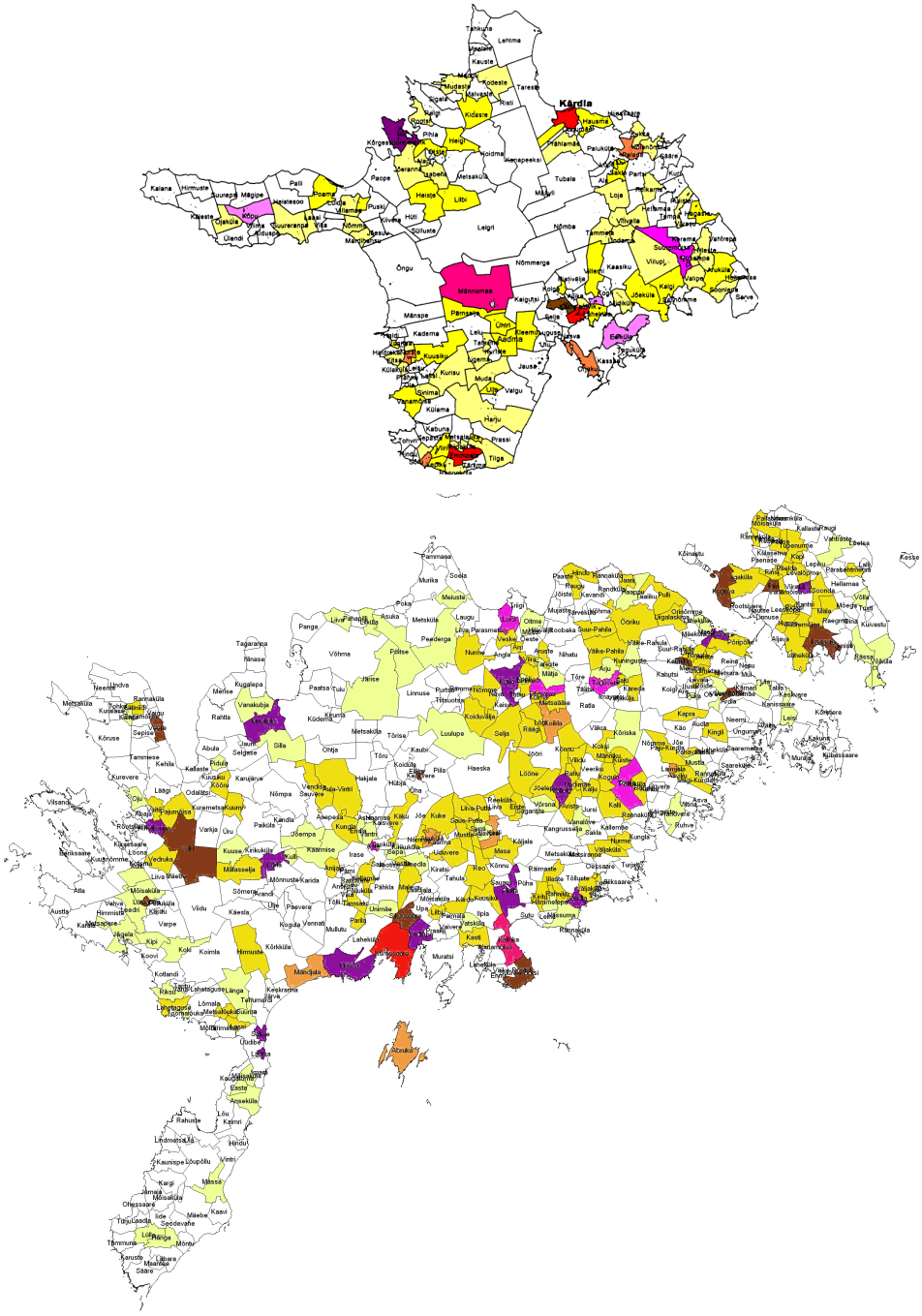
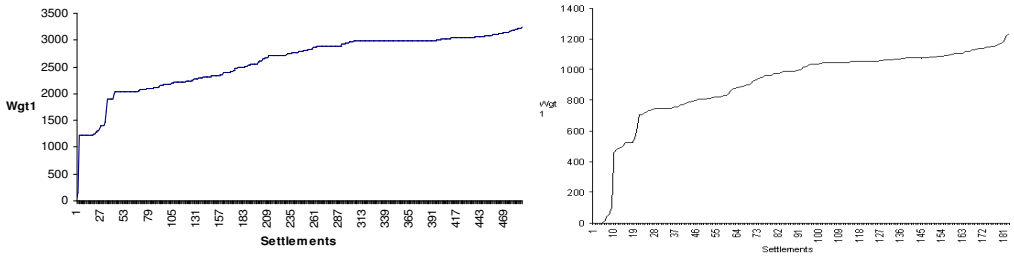


Figure 7. The most typical places in the whole system and central places.
It should reflect everyday life on the islands and local social networks.

5.1.2 System analysis of activities using the weight-function π_1

If we do not include frequencies of zero values (we are using only frequencies of ones in the binary data table), then we are using the weight function π_1.

When the weight function π_{01} is calculated on our sparse data, high frequencies of zeros tend to dominate. The weight function π_1 is calculated using only frequencies of ones. So objects are "typical" (have high weight) when they have many common characteristics and having uncommon characteristics does not reduce object weight. That will provide a somewhat different ordering.



a. Saaremaa b. Hiiumaa

Figure 8. Settlements distribution on the conformity scale of the activity´s system. Settlements and their weights π_1 sorted in ascending order.

As we can see in Figure 8 (a., b.), settlements are divided according to the weights into three groups:

Group 1, weight <1228 in Saaremaa and weight <400 in Hiiumaa. These are the most non-typical villages, with no people living there and the villages have no social characteristics. But they have some economic activities, like a harbour, customs office, border guard, etc, which are supervised from other (central) places.

Group 2, 1228 < weight < 2003 (2037) in Saaremaa, 400 < weight < 700 in Hiiumaa. The second clearly differentiated settlements group has weaker social characteristics (no children in villages) than usual for the observable islands. They have small harbours, coastal fishing, summer-cafés, sights etc. There are also no private enterprises officially.

Group 3, 2003 (2037) < weight, 700 < weight, is the main group in both islands, which can be divided into subgroups.

The main group has villages with different social characteristics: some of them have few children, but it contains also settlements that have rank, headmost population-wise for Saaremaa and Hiiumaa. Most of them have some economic indicators.

As sub-groups are born on the basis of coinciding attributes, social indices of the settlements in the main group are extremely different. The main group also has its own structure, which we will discuss in section 5.1.4.

The first subgroup contains settlements with different social indices, but economic activities are few there – and even these few are of local significance.

The medium subgroup of the main group is comprised of, among others, the most important settlements and also the administrative centres of the islands. A common feature for some settlements in this group is the strong enterprise performance indicators, for others similar demographic and social indicators.

Although the two first subgroups can be visually perceived on the graph, the principal difference between them is quite vague.

On the other hand, the third subgroup of the main group represents the most typical villages – these form a separate group on the basis of most wide-spread social and performance indicators of the island: most of them have a population of ten to fifty, working-age population in all from ten to fifty, up to ten children, retired population also up to ten. These settlements are: Saikla, Kaisvere, Atla, Kaali, Abruka, Vilsandi, Murika, and Taaliku. Activities are typical of the islands: summer holiday activities, coastal fishing, small harbour etc. Undertakings in most typical places today are of local and regional (from the aspect of Baltic Sea region) significance.

With the help of the weight function π_1 we studied social networks about social and economic indicators.

Five most typical settlements in Saaremaa are Taaliku, Murika, Vilsandi, Abruka, and Kaali. The three most typical settlements in Hiiumaa are Sõru, Kalana and Sarve.

Table 6 depicts the most interesting places found in the activity system or with the help of π1-function.

Table 6. The most interesting settlements sorted in ascending order of the weight π_1

Settlement/ place	π_1	Existing attributes	Comment
Hiiumaa			
Group 1 of non-typical places			
NÕMMERGA	0	0	Villages without attributes
SÜLLUSTE	0	0	
TIHARU	0	0	
VIITASOO	0	0	
LEERIMETSA	0	0	
PALLI	15	1	Coastal fishing
TOHVRI	48	2	Beach, sights
LEHTMA	58	12	Existing attributes are related with timber industry: port and related activities, border guard, custom, summer catering, etc.
KAUSTE	106	3	VACATION VILLAGE. Existing attributes: natural protection area, accommodation, summerhouses
Group 2			
LEIGRI	461	4	Total population is 1-10 working-aged inhabitants
JÕESUU	474	5	Small housing place with additional value: total population 1-10 working-aged inhabitants, natural protection area.
HÜTI	488	5	Small housing place with additional value: total population 1-10 working-aged inhabitants, sight
SUURESADAMA	492	10	Port settlement: total population 1-10 working-aged adults 1-10, port, coastal fishing, drive between the islets, boat repear, museum
OGANDI	504	4	DECIDING village or OLD PEOPLE VILLAGE: there live just 1-10 retired inhabitants
HEISTESOO	523	5	Only 1-10 working-aged inhabitants, SUMMERHOUSES (tend to form as vacation villages)
NÕMME	523	5	
TAMMISTU	523	5	
VILIMA	523	5	
MALVASTE	551	7	Only 1-10 retired inhabitants, accommodation, summer catering (tend to form as vacation village)
TAHKUNA	606	8	Total population is 1-10 retired inhabitants, SUMMERHOUSES, sights, natural protection areas, windmill, (tend to form as holiday village)
Main group			
KANAPEEKSI	705	6	YOUTH VILLAGES: total population until 10, children 1-10, working-aged adults 1-10, there are no old people.
KIIVERA	705	6	
36 settlements	...	...	...
KÕRGESSAARE alevik	831	34	Center of community
4 settlements	...	...	...
EMMASTE	882	49	Center of community
12 settlements	...	...	...
KÄINA alevik	960	91	Center of community
49 settlements	...	...	...
KÄRDLA town	1061	109	Capital of county
54 settlements	...	...	...
The most typical Hiiumaa´s settlement based on the π_1-function			
PALADE	1173	23	Housing place: total population 10 – 50 inhabitants; children until 10, working-aged adults 1- 10, retired people 1 - 10, library, school, sporthall, museum, ...
SARVE	1188	13	Developing VACATION VILLAGE: Total population 10 -50 inhabitants, children 1 - 10, working-aged adults 1 - 10, retired people; SUMMERHOUSES, accommodation, beach, ...
KALANA	1222	15	Developing VACATION VILLAGE total population 10 – 50 inhabitants, children 1-10, working-aged adults 1- 10, retired people 1-10, population; SUMMERHOUSES, sights, beach, coastal fishing, port, weather station, accommodation, ...
SÕRU	1228	21	Developing VACATION VILLAGE total population 10 – 50 inhabitants, children 1-10, working-aged adults 1- 10, retired people 1-10, population; SUMMERHOUSES, sights, beach, coastal fishing, port (dock), summer catering, museum, ...

SAAREMAA	π_1	
I group of non-typical places		
LÕU	67	Port (warf)
MÕNTU	151	Port
II group		
PAIMALA ... IRUSTE, 16 settlements	1228	Villages with up to 10 working-aged inhabitants (deciding villages)
KIIRASSAARE ... METSAKÜLA, 14 settlements	1242 ... 1478	VACATION VILLAGES: up to 10 retired and up to 10 working-aged inhabitants and VACATIONERS, among these villages places vith natural protection values existing
Group 3		
SÄÄRE	1665	VACATION VILLAGE: only 10-50 working-aged inhabitants. Vacation activities, summer houses, warf
Group 4		
JOOTME... RÄIMASTE, 6 settlements	1897	YOUTH VILLAGES, children 10 and until 10 working-aged adults, there are no old people
LAHEKÜLA	1900	YOUTH VILLAGE, children 10 and until 10 working-aged adults, there are no old people, additional activity is forestry.
Exception before the main group		
TÜRJU	2143	VACATION VILLAGE: NO CHILDREN, and working-aged people, only old people. HOLIDAY ACTIVITIES, warf, beach
Inside the main group ...		
KÕRUSE ... VÄLJAKÜLA, 88 settlements in the main group have excactly the same value (weight) in the case of the both weight function.	2985	Basically demographic indicators: total population 10-50 inhabitants, few children (1-10 per village), working-aged adults until 50, retired people belowl 10. VACATIONERS, among these villages places with natural protection values existing
Exception between the non-typical and typical villages		
ARANDI	2003	Housing place with >100 inhabitants, number of children is 50 -100, no more indicators, except for demographic attributes
I group of typical places		
ASTE alevik ... Väkra, 25 settlements	2037	Settlements with very different attributes together. Aste is a housing center in the hinterland of Kuressaare. Number of population in Aste is >100, children >100. There are the primary services, like school, kindergarten, store,library, agricultural enterprise (farming) etc. Väkra, Anepesa, etc are villages with <10 inhabitants, without children.
The most typical Saaremaa´s settlements based on the π_1-funktsioon		
SOELA, PAMMANA, PAENASE, LINDMETSA, KUNGLA, SIIKSAARE, LAADLA, SAAREKÜLA, NINASE, MUJASTE, SUTU, KAAVI, KAVANDI	3136...3177, 3191	DICHOTOMICAL VILLAGES: total population 10-50 inhabitants, children 10, VACATIONERS, HOLIDAY ACTIVITIES, additional values are warfs, landing places, beaches (developing vacation villages)
SAIKLA	3201	Economic village with 50 inhabitants timber- and plastic industry, repair and construction enterprises, sewing enterprise, etc., turnover of the settlement over M
KAISVERE	3201	Agricultural settlement with up to 50 inhabitants
ATLA	3201	DICHOTOMICAL VILLAGE: total population 10-50 inhabitants, children 10, VACATIONERS, HOLIDAY ACTIVITIES, additional values are warf, beach, natural protection area (developing vacation village)
KAALI	3215	Tourism center and economic village and housing place: total population 10-50 inhabitants, children 10, sight, tavern, catering, accommodation, store, school, library, post-office, timber enterprise, enterprises have growing turnover, turnover of the settlement over M
ABRUKA	3217	Self-standing island: total population 10-50 inhabitants, children up to 10, port, accommodation, agricultural activities (green farming), natural protection area
VILSANDI	3225	Self-standing island: total population 10-50 inhabitants, children below 10, VACATIONERS, HOLIDAY ACTIVITIES, a PORT and a WARF; additional values: sights, natural protection area, drive between the islets, weather station, etc.
MURIKA	3232	Developing VACATION VILLAGE: total population 10-50 inhabitants, children belowl 10, VACATIONERS, HOLIDAY ACTIVITIES, additional values: warf, beach, accommodation
TAALIKU	3243	(Agricultural settlement): Inhabitants 10-50, children below 10, beach, basic services: store, library, agribusines enterprise (farming)

The population of the most typical villages in both Saaremaa and Hiiumaa is 10-50, and the number of children up to 10. The working-age population of the most typical villages in Saaremaa is 10-50, in Hiiumaa up to 10, which can be explained by the smaller population of Hiiumaa.

Activity indicators for both islands also coincided: in most typical villages in Hiiumaa only vacation related activities were dominating. The most typical villages in Saaremaa could be divided on the basis of activities into three groups: VACATION VILLAGES (Murika, Vilsandi, Atla, Abruka), ECONOMIC VILLAGES (Kaali, Saikla), and AGRICULTURAL VILLAGES (Taaliku and Kaisvere). The most typical villages in Hiiumaa – Sõru, Kalana and Sarve – can be regarded as VACATION VILLAGES where also economic activities occur. Most of the typical island villages are located by the sea, and the islands are historically-culturally engaged with marine activities, which today are valued again, and settlement is traditionally concentrated by the sea, which is particularly contrasting in Hiiumaa where the inland is quite deserted.

We are interested in whether or not the typical Baltic Sea island villages are viable and capable of further development. As we can see from Figures 5a and b where the trendline shows a rising trend, and from Figures 6 a and b where the point pattern seems to be falling from the association of typical villages, or toward settlements with higher development indicators, we can predict that the most typical settlements are capable of development. We provide a more precise answer to this question in the section of management functions.

Overall, we can say that the weight function π_1 identified mostly purely functional relationships. The hierarchy of settlements was identified with the weight function π_{01}.

The settlement system in Saaremaa is well established, as there are many settlements with a similar weight and attributes, settlement groupings coincide on the basis of both of these functions.

The settlement system in Hiiumaa is still under development or in the phase of transformation, since grouping of the settlements is still continuing and the attribute values were different in each function, places have not yet a definite position in the system and their further development is unclear.

As the weight functions brought out different aspects, we examine them in a combined function in the next section (5.1.3).

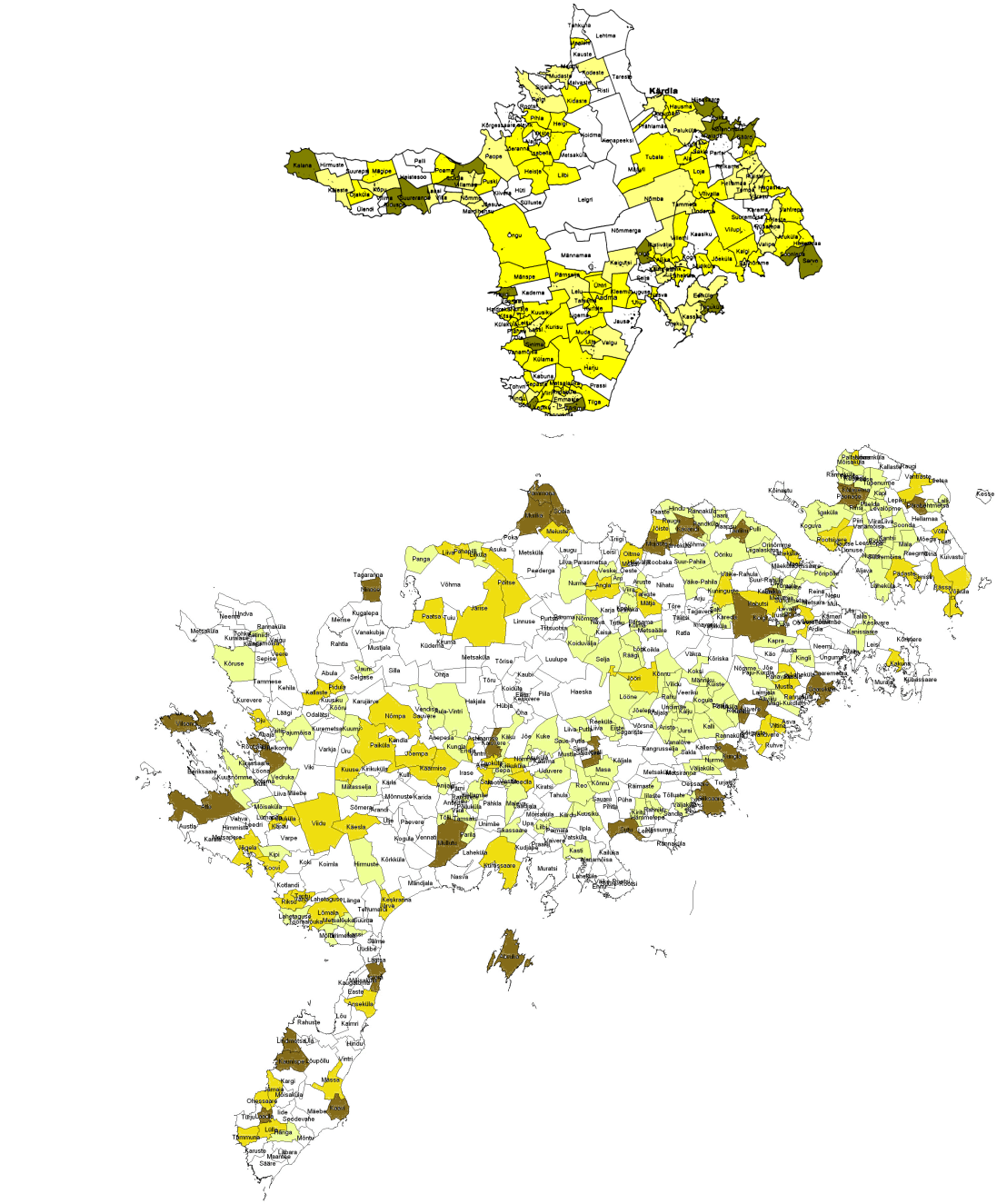
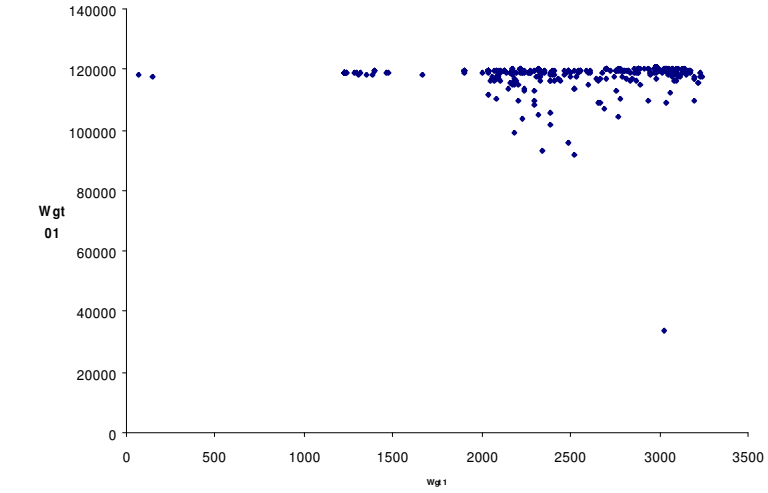


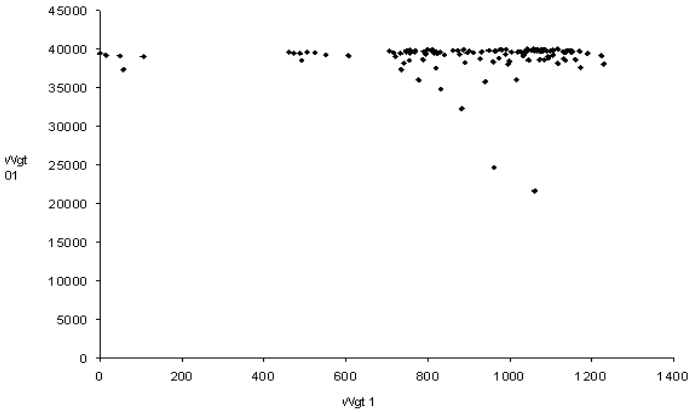
Figure 9. Social network based on the attributes of activities (activity concepts).

5.1.3. Combined weight functions on the Conformity Scale

As the functions (π_{01} and π_1) pointed out different aspects, from the aspect of grouping, the best results can be received by comparing the results of the above-described weight functions by combining the two functions in an Excel graph, Figure10.



a. Saaremaa



b. Hiiumaa

Figure 10. Composite view of the conformity plot: distribution of settlements in terms of comparison of weight functions π_{01} and π_1 on the conformity scale.

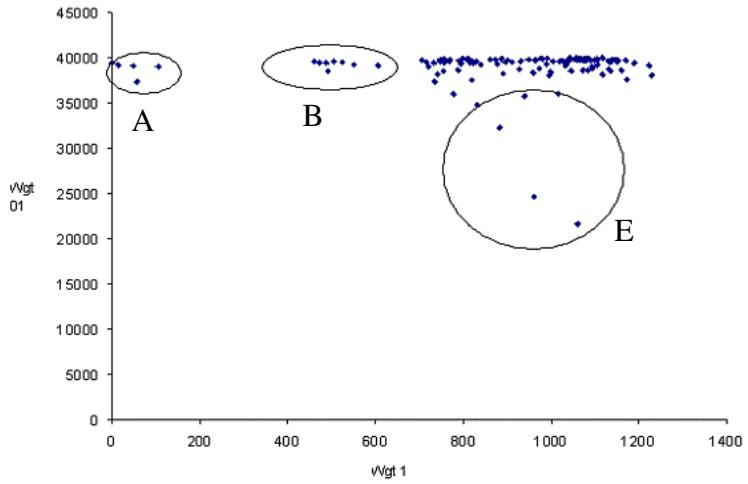
As can be seen, three distinctive groups can be perceived on the pull scale π_1 of the chart in Figure 10. On the push scale π_{01} we can clearly distinguish large settlements, such as Kärdla, Käina and Emmaste (weight < 35000) in Hiiumaa, Kuressaare, Orissaare etc. in Saaremaa.

As the previous subsection showed, the ”main series” can be distinguished on the π_1 axis of the weight function, which contains most of the elements, and two separately standing groups (here) on the left side of the ”main series” in Hiiumaa and four in Saaremaa. These two are settlements without population (weight in Saaremaa < 1000 (500); weight in Hiiumaa < 400) and children (in Saaremaa 1000 (500) < 1500; Hiiumaa 400 < weight < 700). The village of Sääre, which forms a separate group in Saaremaa, is a purely vacation village with the weight of 1665. And the fourth separate group is formed of YOUTH villages (with the weight >1666 > 2000). In the case of Hiiumaa the youth villages (Kiivera, Kanapeeksi, etc) are located at the beginning of the main group.
All the above-mentioned groups are located left of the main series on the chart and their descriptions are provided in the subsection above, in Table 6.

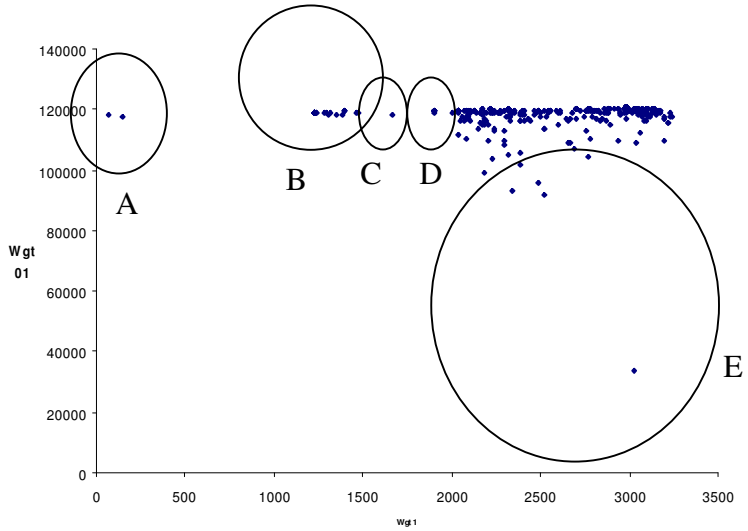
Large settlements located in the “main group” on the weight function π_1 chart of ones are now again beneath it, since they proved to be exceptions in the co-weighting of zeros and ones. Due to the multitude of activity indicators and the small number of zeros, central settlements and economically advanced villages form a dispersed group of points beneath the ”main series”, among which the most important are: Orissaare, Nasva, Kärla and Valjala (weight < 100000). Kuressaare (weight 33693) is strongly detached from the ”main series“. Hiiumaa Kärdla and Käina form a detached duo, in Figures 10 and 10.1.

Some easy-to-detect outlier groups are shown in Figure 10.1:
A: The most non-typical villages, where no people live. Group I from section 5.1.2
B: No children in these villages. Group 2 from section 5.1.2.
C: Pure summer villages 5.1.2 in Saaremaa
D: Youth villages 5.1.2 in Saaremaa.
E: Large settlements and administrative centers mentioned in section 5.1.1.

Groups C and D exist in Hiiumaa also, but they do not have such a clear separation from the main group there.



b. Hiiumaa



a. Saaremaa

Figure 10.1. Distribution of the settlements in terms of comparison of the weight functions π_{01} and π_1 on the conformity scale: Groups of outliers.

Groups of exceptions (see Figure 10.1) on the combined scatterplot include three sorts of settlements or places in Hiiumaa and four sorts in Saaremaa: a group met only in Hiiumaa consists of villages without any population; the second group on both islands comprises the harbour villages Lõu and Mõntu in Saaremaa and Lehtma in Hiiumaa. The third group is formed of villages with people but no children, most of them incorporate places with holiday activities. The holiday village Sääre (also with no children) in Saaremaa is a separate point and the last group of exceptions is the youth villages (young adults and children).

Vertically, exceptions are formed by larger settlements.

The main group has been divided into halves or two up to three subgroups.

The first subgroup has villages with different social characteristics: some of them have few children, but it contains also settlements that have rank, third and fourth population-wise for Hiiumaa and fifth, sixth and seventh for Saaremaa and Hiiumaa. Most of them provide some economic indicators.

The centre of the main group is formed by most important settlements in islands, including administrative centres. Parts of them are related by strong economic and private investment variables, others are connected by similar social characteristics, like the most typical settlements according to the scale of π_{01}-function.

The main group ends with the most typical villages in the scale of π_1-function with more of activities. This group is based on the most widespread social characteristics and activities, like leisure, coastal fishing, small harbour etc. Population of these settlements is 10 up to 50 inhabitants, they all have children, workers and elderly.

Combining the conformity plot with information from frequent itemsets[5] or association rules is one of the promising ways to provide semantic information about visual clusters. For example, frequent itemset containing villages with workers, elderly and 1 to 10 children splits main groups into halves in both islands.

The structure and semantics of the main group is analyzed in the next subsection (5.1.4).

A comparison of functions on the chart points out all possible linkages based on whether the ”events“ take place (existence of indicator) or not; and in these conditions the main group is formed of points (settlements) with the same or similar attributes. Major settlements have separated from the main group because of the multitude of activity indicators (small number of zeros) – and the pattern characterizing the settlement system of islands takes clear outlines, which can be seen on the drawing in Figure 11.

Substantially, vacationers and local people have no significant contacts; their activities and social networks rarely coincide. Vacationers (primarily newcomers) do not settle in locals' villages in spite of the open sea view etc. , the factor that seemed to be important, based on this study. It particularly strikes the eye in the analysis results of Saaremaa where vacationers form a separate concept and also the map shows that in comparison with local social networks quite different places are important. The survey results in Hiiumaa confirm the same tendency, which does not show so sharply in the results of the analysis.

[5] Frequently existing itemsets. Itemset is a given subset of all variables that have given values.

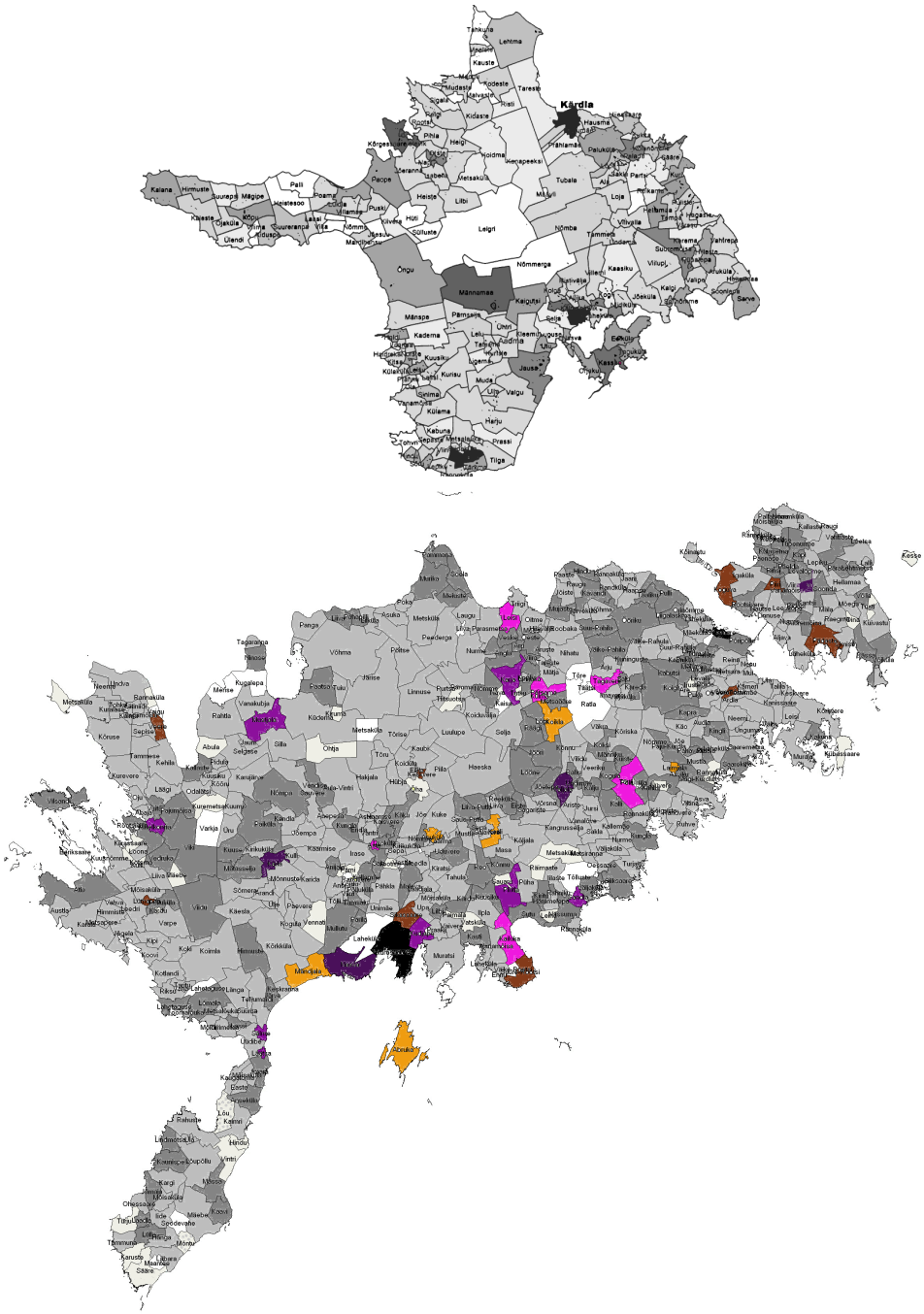


Figure 11. Social networks on Estonian islands by the conformity scale.

Although surveys have implied that the previous presence of other people (village centrality, orientation) is important for settling in that place, other criteria for choice are obviously have to do with cognitive kind of factors that will be investigated further.

Similar tendencies occur also among local people themselves: on the basis of both analyses there are villages with only working-age and old people, and villages with some working-age people and quite many children for them (let us call them youth villages, e.g. Jootme, Räimaste, Laheküla etc.).

5.1.4 Association´s internal structure: ordering of the weights

We noticed that the main group has its own internal structure and the points (settlements) are placed on the chart according to some rules, which also describes the possible development path of that settlement.
In the given subsection we show the content side of the structure of the main series from the aspect of settlement research.

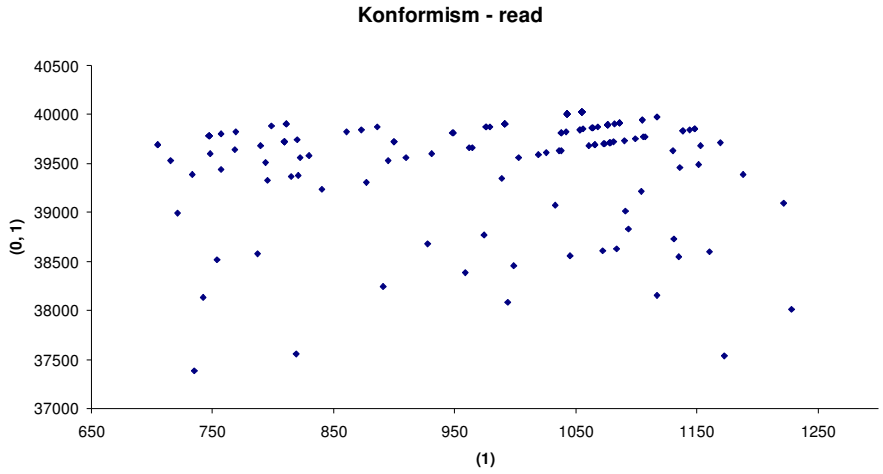


Figure 12. Internal structure of the main association on the conformity scale.

By increasing ”the main series” in the settlements´ scale of conformity chart we can see diagonal stripes (Figure 12). A common denominator of the settlements in the "stripes" is the number of true values of the attributes. Beneath the stripe of settlements with ten true values there is a stripe of settlements with nine true values, and beneath it a stripe of settlements with eight true values etc. This is a mathematical attribute of weight functions π_1 and π_{01} in the binary tables, which I have verify in the subchapter 4.2.2.1, part of ”Methodology“.

As mentioned in the subsection 4.2.2.1, the rows of points or “stripes” have a meaning in both ways from left to right and from top to bottom: the number of attributes in the stripe is

growing, and so does the number of common attributes in the stripe: when the indicators of parallel points are different in some places, then points from top to bottom have exactly the same attributes, but the lower points have a larger number of indicators. The vertical rows also show from left to right the amount of coinciding point attributes, which is the smallest on the left margin and biggest on the right margin. A reason is that the settlements on the left margin have less attributes and hence also less possible coinciding attributes. The typical, right margin villages are linked by a number of wide-spread indicators – possible coincidences are more numerous.

Points on the left of the chart are settlements with non-typical attributes for the system. These are, for example, settlements without any population, which are on the left margin of the chart and form a separate distinctive group. The largest settlements on the islands are also located on the left side of the large group (association), as these have many attributes that the other settlements, as a rule, do not have. For example, typical settlements for the system, harbour settlements Murika, Vilsandi, Taaliku (Saaremaa) and Kalana, Sõru and Sarve (Hiiumaa) are on the right margin of the chart below one another, hence forming a vertical row. And, for example, Sõru is located lower because its total amount of attributes is larger than that of Kalana. The common part of these attributes consists of twelve coincidences.

As the weight function π_{01}, as different from the weight function π_1, points out pushing forces between the points, it also explains the compression of the group of more typical settlements, and in that scale as well as in Figure 12 large settlements with more attributes can be distinguished.

It was found that the main group is characteristic of own internal structure and the points (settlements) are placed on the chart according to some rules. It appears also to describe the possible development direction of that settlement.

The settlement system of the islands is characterized adequately and in detail on the map in Figure 13. It shows the core surroundings of economic development for Kuressaare (Saaremaa) and Käina (Hiiumaa). Self-contained concepts are formed by the holiday villages, economic settlements, agricultural villages and living places (housing space). Even on the map (Figure 13) we can recognize the lines of the roads, despite the fact that the commensurate data were not entered for information processing.

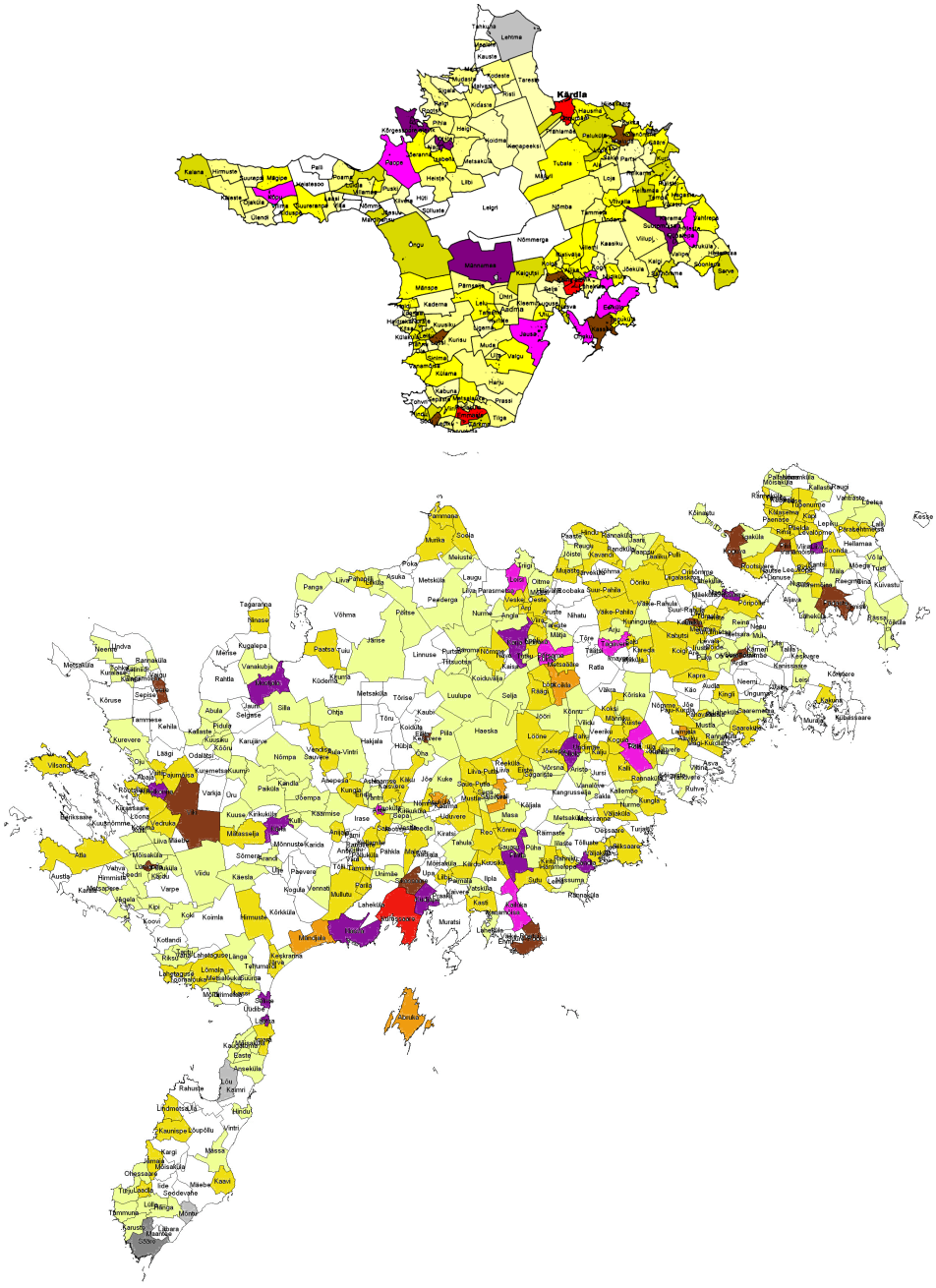


Figure 13. Internal structure of the islands settlements patterns by the conformity scale.

As is shown, in the graphic structure in Figure 10 (a, b.), in subsection 5.1.3, larger settlements have been separated because of the multitude of activities. If the leading settlements have already realized their position in the hierarchy, then recently separated villages have still enough potential for development, as will be shown through the analysis data with the management functions in subsection 5.3.

In this subsection we have demonstrated the content side of the structure of the main series from the aspect of social space study, also tested with the help of the Formal Concept analysis elaborated by Wille, Stumme and Ganter (1998, 2001, 2005) that is used worldwide.

5.2 Test with a Formal Concept Analysis: sorting concepts using the technique of minus

We studied also an interesting method for knowledge discovery that combines elements from the formal concept analysis and the theory of Monotone Systems.

In principle, Monotone Systems and Lattice-based Analyses identified the same concepts, such as holidaying activities and the presence of vacationers (accommodation, beaches, summer houses and their location in the villages), population topics, concepts of centres, agricultural villages, economic villages (e.g. Nasva in Saaremaa, Nõmmeküla, Kassari in Hiiumaa). As a methodical innovation we sorted our data with the minus technique of monotonic systems worked out by Võhandu and Mullat (1976). It was proved that the kernel from the Minus Technique sequencecan be found, the monotone weight function that forms the core of our method was defined and it can be shown that it has a certain invariance property. Thereafter the iceberg concept lattices, methods of blocks and nested line diagrams were applied. As a result, the networks in Figures 14 and 15 were received.

In Figures 14 (H1, H2) and 15 (S1, S2) the ontological framework of the island´s everyday semantic structure is represented.

A detailed representation is given in the article ”*Sorting Concepts by Priority Using the Theory of Monotone Systems*“ (Torim, Lindroos, 2008).

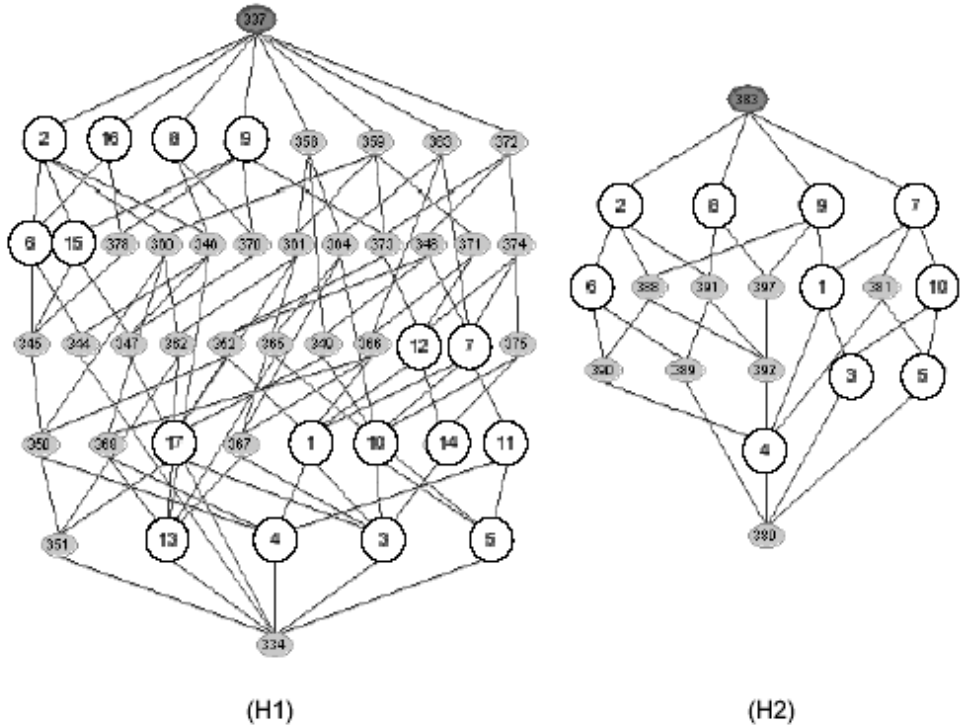


Figure 14. Formal concept lattices H1 and H2 for Hiiumaa.
Concepts in H1 and H2 are marked with large numbered circles.

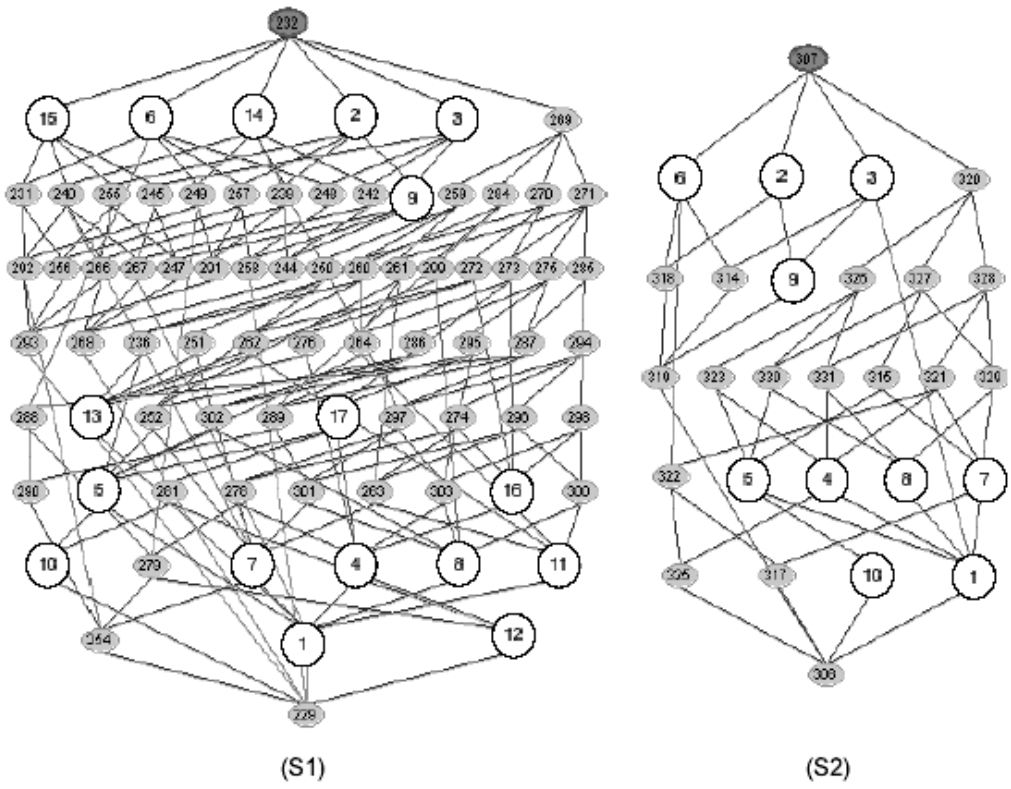


Figure 15. Formal concept lattices S1 and S2 for Saaremaa.
Concepts in S1 and S2 are marked with large numbered circles.

Figure 14 presents the concept lattices for Hiiumaa and Figure 15 shows those for Saaremaa. Below in Table 7 the list of formal concepts for Estonian islands is presented.

Table 7 List of the formal concepts for Saaremaa and Hiiumaa

No of concept	Weight	Nunber of attributes	Settlements/ Comment
Hiiumaa			
1	116	58 s	KÄRDLA, KÄINA
2	250		68 settlements, summer houses
3	382	83	KÄINA
4	574	101	KÄRDLA
5	625	41	EMMASTE
6	747		17 settlement, summer houses, beach
7	1050	25	KÄRDLA, KÄINA, EMMASTE
8	1352		22 settlements, agriculture
9	1536		32 settlements, housing
10	1974	27	KÄINA, EMMASTE
11	1976	28	KÄRDLA, EMMASTE
12	2277	16	KÄRDLA, KÕRGESSAARE, KÄINA
13	2717	22	NÕMME
14	3000	19	KÕRGESSAARE, KÄINA
15	3620		15 settlements, summer houses, housing
16	4130		22 settlements, beach
17	4444	17	KASSARI, KÄINA
Saaremaa			
1	179	s179	KURESSAARE
2	272		68 settlements, warfs or landing places for fishing boats
3	456		87 settlements, summer houses
4	936	52	KURESSAARE, ORISSAARE
5	1204	47	KURESSAARE, NASVA
6	1878		55 settlements, agriculture
7	2007	44	KURESSAARE, KÄRLA
8	2409	39	KURESSAARE, VALJALA
9	3330		32 settlements, warfs, summer houses
10	3582	54	NASVA
11	4448	35	KURESSAARE, LIIVA
12	4910	58	ORISSAARE
13	5681	30	KURESSAARE, KUDJAPE
14	6534		56 settlements, housing
15	7449		41 settlements, sights
16	8085	24	KURESSAARE, ORISSAARE, LIIVA
17	8550	17	KURESSAARE, VALJALA, TORNIMÄE, KÄRLA

There seems to be a clear division between concepts describing small monofunctional settlements (agriculture, summer houses) and larger regional centres (Kärdla, Käina, Kuressaare), as shown in Figures 14 and 15. That division appears to be clearer in the case of Saaremaa where larger centers represented by the ”artifical“ concept in the upper right corner of lattices S1 and S2 (Figure 15) do not have attributes common with concepts describing monofunctional settlements. The upper right ”artifical“ concept for S1 has a value (several enterprises with a turnover of over million Estonian kroons), (Kudjape, Nasva, Kuressaare, Kärla. Liiva, Orissaare, Tornimäe, and Valjala). Summer villages (also the places with leisure activities) have an important concept.

As we can see, in the list of major concepts in Table 7 these coincide with the point groups found in the Conformity Scale. Similarly with the conformity analysis, large settlements, holiday villages, economic villages, agricultural villages and housing villages with different social indicators form separate concepts. Hence, the formal concept analysis supports our work both as a test method and also in terms of the content.

As a result of comparing our graphs with random data that have the same frequency of ones and size as the data table for Hiiumaa, it was found that the graph of the minus technique sequence is heavily influenced by the internal structure of data (Torim,Lindroos, 2008).

Analyses have shown that the minus technique of monotone systems finds out fine structures. It is easier to make generalizations both in this research area and presumably also in other spheres with the help of the scale of conformity by composing a rough structure, or using the formal concept analysis. However, the scale of conformity is a precondition for the Minus Technique, and the Formal Concept Analysis was conducted on the basis of data previously sorted with the Minus Technique.

The Minus Technique is also used the next subsection of data analysis using the management functions.

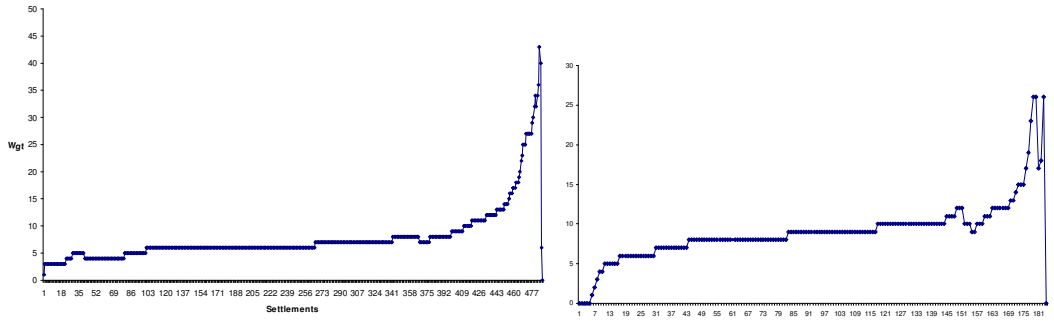
5.3 Data analysis using the management functions

This subsection discusses the problem of analysis and improvement of settlements organizational and hidden structures and nested hierarchy, using the methods of Monotone Systems (Techniques of Minus and Plus) and the management functions distribution matrices. Sufficient conditions for a rational change of these matrices are given. The analysis of the organizational structure and applying the conceptual approach to the structure of organizations was done. Two different management functions are used (Kuznetsov, Muchnik, 1982). The essential difference between these functions is as follows:

(1) Administrative activeness is measured by a weight function, where the weight is assigned according to such functions that are not represented in other settlements.

(2) Incompetence function assigns the weight to the settlement by subtracting the number of functions that are performed by the settlement from the overall functions that are performed by settlements in general.

A detailed explanation of the given methods is well-documented in the part of "Methodology" (subsection 4.2.3).



a. Saaremaa b. Hiiumaa

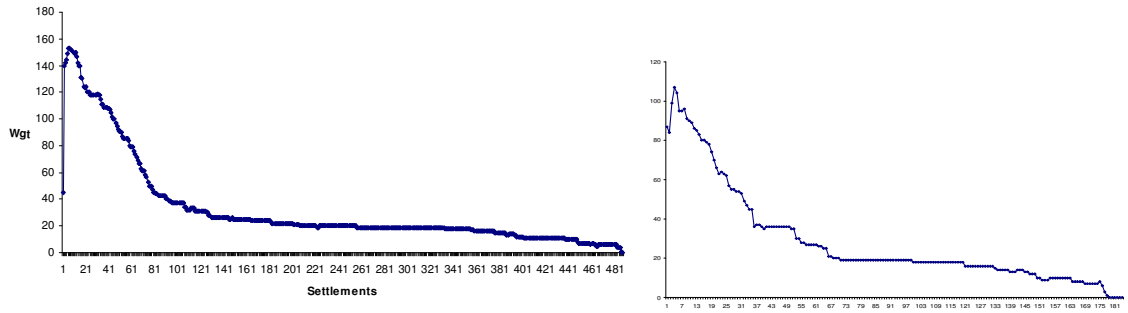
Figure 16. Function of administrative activeness for (a) Saaremaa and (b) Hiiumaa.

According to the first function "Administrative activeness", Saaremaa has a clear settlements hierarchy.

Hiiumaa is characterized by an overlay for the leading settlements, as shown in Figure 16: Some villages are both leaders and actors at the same time. They are so-called "grey eminences" (potential by new leaders), which have implicated encompassing villages.

In terms of the management activity, Saaremaa has only one definite (1) leader settlement – Kuressaare; the next ones (2) (Orissaare, Nasva, Kärla) although they fulfil the leader's role, they all have essentially lower weights than Kuressaare. (3) All the other settlements in Saaremaa are so-called executors. In Hiiumaa there is (1) a group of peak settlements comprising Kärdla, Käina, and with some derogations also Emmaste, (2) plus so-called "secondary stage" group of leaders (Kõrgessaare, Nõmmeküla, Kassari etc) whose welfare depends directly on peak settlements, in this case on Kärdla and Käina; (3) all the other settlements in Hiiumaa, including such regional centres as Männamaa, Palade, Suuremõisa, have the role of an executor. Executors, in turn, are grouped into subgroups, depending on the development level (Figure 16).

In a system the functions should be divided/distributed; stress is caused by a conflicting overlap – coordinators and executors have one and the same tasks (being in the role of leader and executor simultaneously). In the settlement system of Hiiumaa such overlapping occurs in the case of regional centres or "secondary" leaders like Kassari, Kõrgessaare and the satellite settlement of Nõmme village.



a. Saaremaa b. Hiiumaa

Figure 17. Function of competence for (a) Saaremaa and (b) Hiiumaa. Foremost detach villages with more administrative activeness and less incompetence.

The management activity chart has quite well illustrated grouping of the settlements and the competency chart draws a clear distinction between the leader settlements and the others. By the management activity or competency function depicted in Figure 17, competent (leading) settlements in Saaremaa are Kuressaare, Orissaare, Nasva, Kärla, Valjala, with some derogations also Liiva; in Hiiumaa – Kärdla, Käina and Emmaste; all the others are in the sphere of influence of Kärdla and Käina. Selection into groups is not so clear here as on the management activity chart, but the trend from top to lower settlement spheres is the same in general.

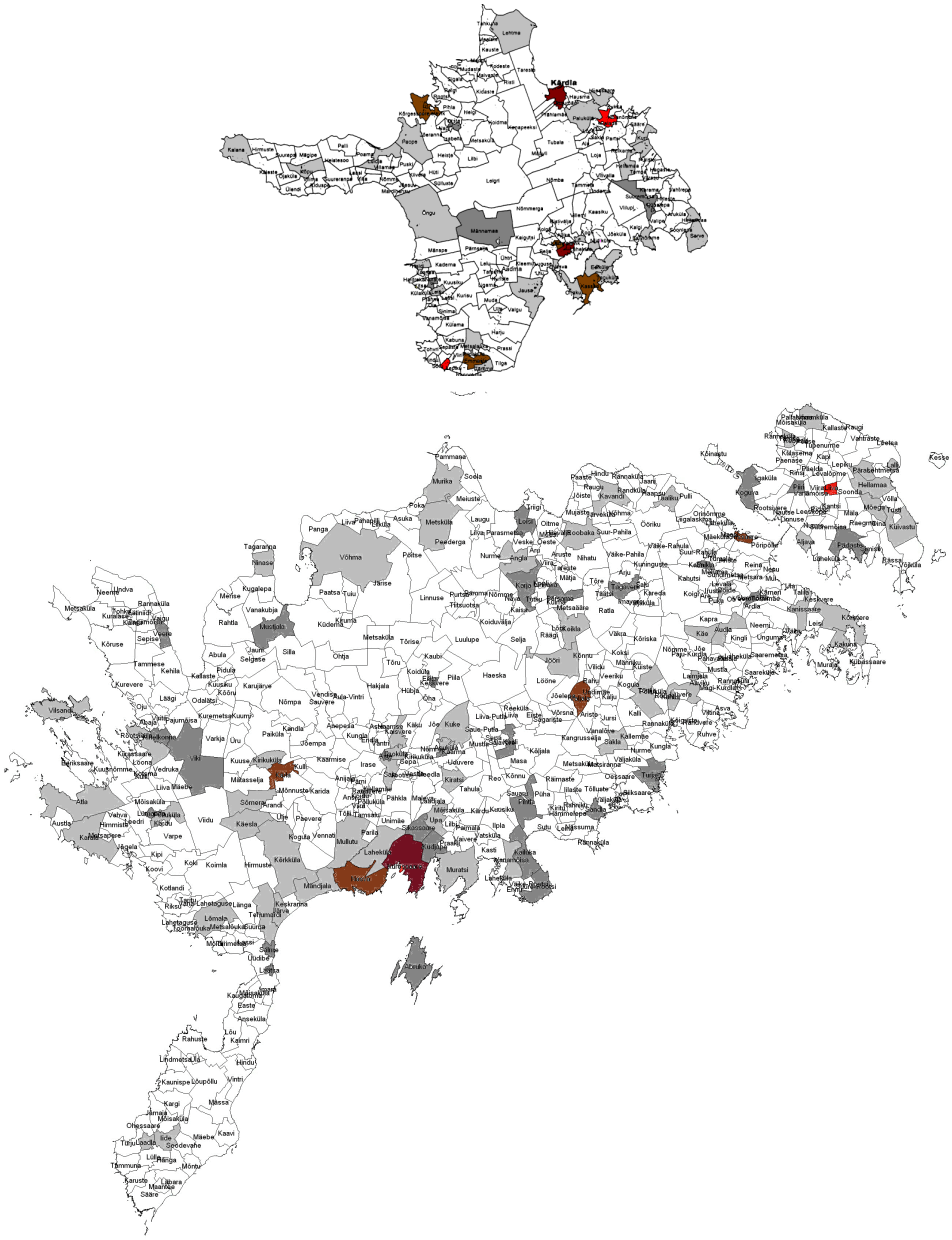
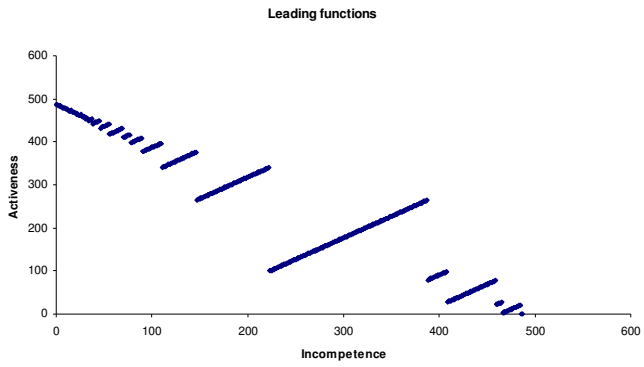


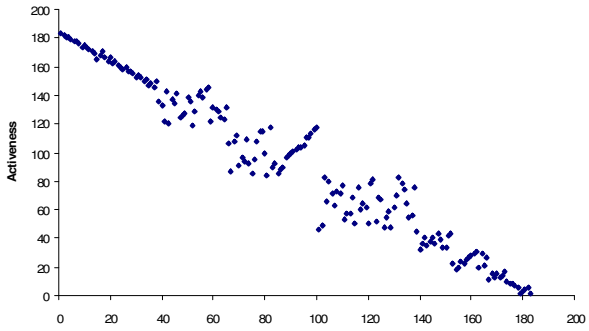
Figure 18. Settlement patterns leadership of the Estonian islands.

Also, we have seen, that using the algorithms of leading functions we can separate all active places and build a hierarchical system for the settlements.

If both of the leading functions are combining their settlements weights into a single scatterplot (Figure 19 a, b.), then viable villages pull together and push weaker ones to the outside. They form some different groups. In the plot visualization there is a clear difference between viable active settlements and others with low social characteristics.



a. Saaremaa



b. Hiiumaa

Figure 19. Development´s identity of the places in (a) Saaremaa and (b) Hiiumaa. Combined activeness and incompetence scale for islands settlements

In Figures 19 (a and b) villages have been clearly divided into halves: upper ones pull to the activeness, others to the incompetence. It shows us the developmental rank of islands villages. On the basis of Figure 19, more viable settlements are in the upper associations, but active settlements in economic terms in Saaremaa might be between 487-340 from the activity scale on y-axis, 0-222 on x-axis (from Kuressaare to Vanalõve), and in Hiiumaa from 183 to 142 from the activity scale (y-axis), or from Kärdla to Suursadama. The lower association denotes small low-activity villages on both scatterplots.

More powerful settlements attract also villages with better social indicators where nothing significant happens besides living and holidaymaking. Therefore there is a clear difference between settlements on the chart: more active and simultaneously more viable ones pull towards activity; villages and places with lower social indicators where there is no activity, including some peripheral villages of larger settlements, towards incompetency.

Comparison of Saaremaa (a) and Hiiumaa (b) in Figure 19 delineates the established settlement system in Saaremaa and transition stage villages in Hiiumaa. Further development

of Hiiumaa villages, which show as a scattered association in the figure, and also their identity, are unsettled: they have a potential of development or they will die out gradually.
The existent leading settlements have already realized their position in the hierarchy. Recently separated villages have still enough potential to develop.

Villages close to the top can evolve, because of their good and convenient characteristics, which support development and are similar to the top villages.

The pattern of Saaremaa´s and Hiiumaa´s settlements by their activeness represented as a map picture is shown in Figure 20.

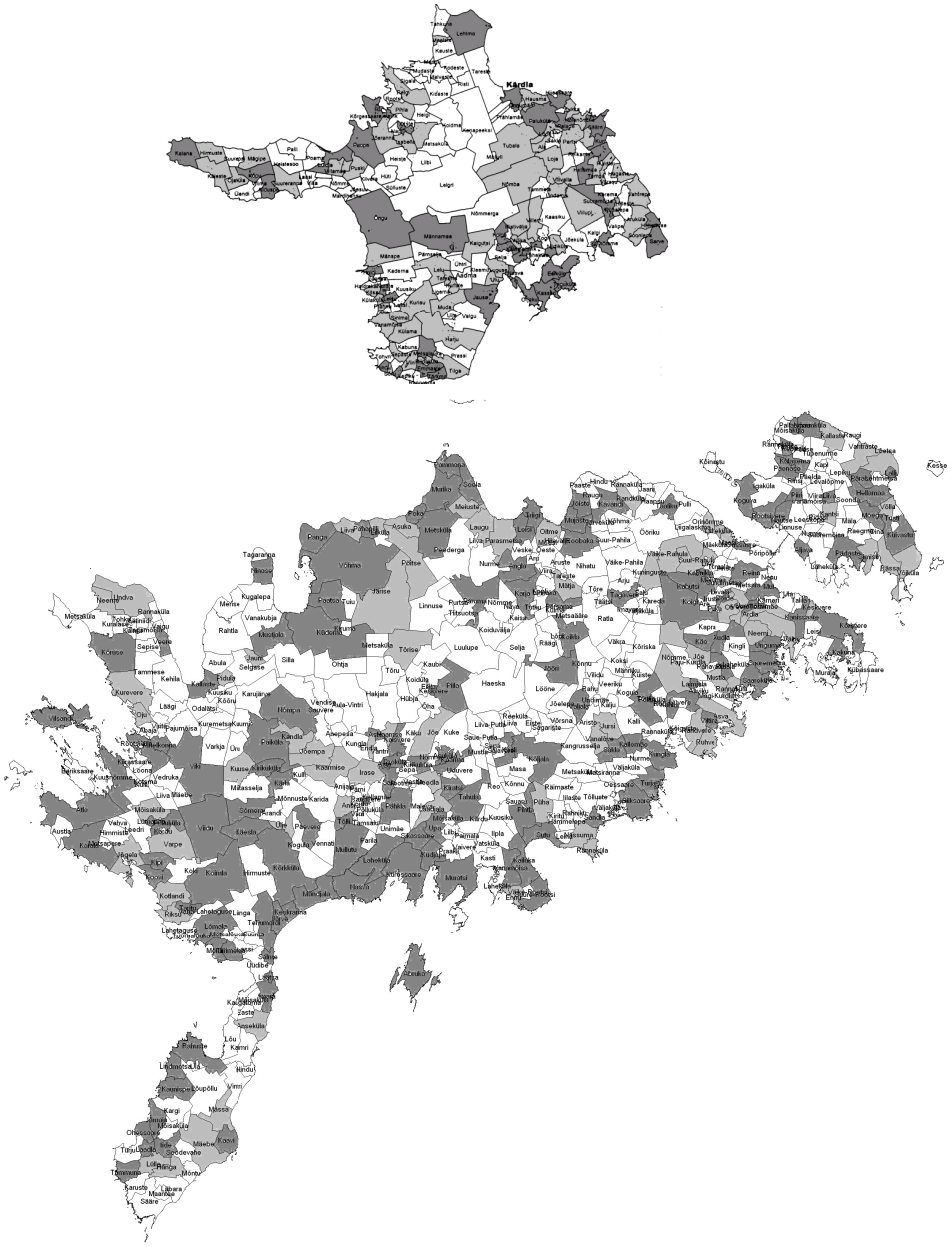


Figure 20 Saaremaa´s and Hiiumaa´s settlements pattern by the activeness and development´s identity. Villages between activeness and incompetence have been represented with gray-scale. Centres and developing areas are darker than other ones. Weak villages are white.

5.4 Distribution of the attributes in the Conformity Scale and Monotone Systems

In order to analyze places we selected a number of different attributes, including activity indicators and geodata from different categories, which are not comparable using traditional statistical methods: business and economic variables, intervals of economic indicators, growth/decline trends of indicators, intervals of demographic indicators, cultural and social indicators, territories and objects under nature protection, beaches, agricultural activity, service providers (including public sector), technical infrastructure such as airfields, ports, landing places that can be characterized as indicators essential for human activity on a small territory.

On Estonian islands there are not so many activities that have economic significance and it is the same way with them as with the settlements that most of the functions/indicators occur once or twice/three times in major settlements or in some intermediate village with a small industry; and only demographic indicators are common for a significant amount of villages, Figure 21.

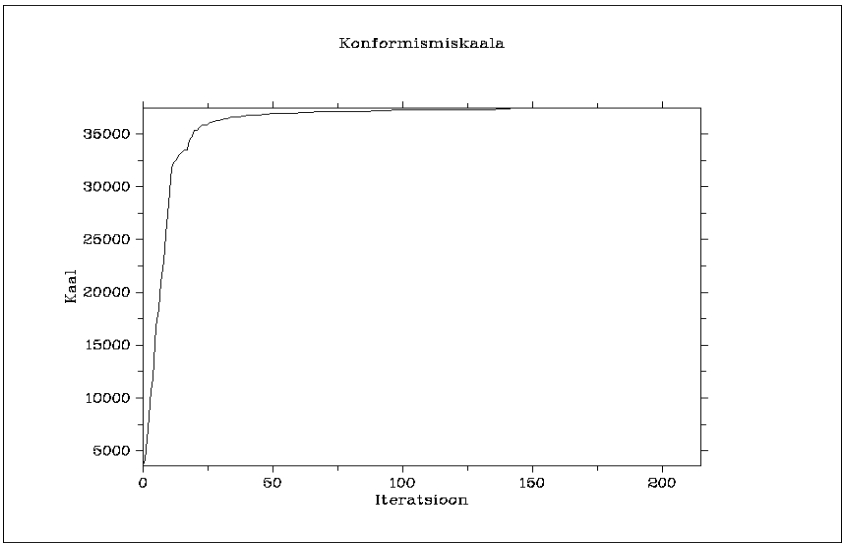


Figure 21 Distribution of the attributes on the conformity scale in the whole system. A small share of the indicators (social indicators) is represented in most of the villages. The rest of the indicators in the systems are very few.

Consequently, a small share of the indicators (mostly social indicators) is represented in most of the villages. The rest of the indicators occur rarely.

All of the outliers are presented in Table 8.

Table 8. The most important social-economic indicators for Saaremaa and Hiiumaa, which are active in the settlement system structure in Estonian islands

Saaremaa (between 5-95%)				
Characteristic	**Code**	**1- values**	**Percentage**	**Comment**
library	T8B	26	0.053279	
port	T4	27	0.055328	
population over 100	RA4	32	0.065574	
working-aged 50-100	TE3	36	0.07377	
store	T3	39	0.079918	
beach	T15	40	0.081967	
sight(s)	T16	41	0.084016	
Turnover k5	T200	43	0.088115	
farming	T7	55	0.112705	
accommodation	T6A	56	0.114754	
warf (landing place for boats)	T25	68	0.139344	
population 50-100	RA3	70	0.143443	
children 10-50	L2	72	0.147541	
retired 10-50	P2	79	0.161885	
summerhouses	T23	87	0.178279	
population 1-10	RA1	104	0.213115	
working-aged 1-10	TE1	162	0.331967	
working-aged 10-50	TE2	265	0.543033	(0, 1) weak influence
population 10-50	RA2	280	057377	(0, 1) weak influence
children 1-10	L1	294	0.602459	
retired 1-10	P1	362	0.741803	
children bt.	L0	377	0.772541	
retired bt.	P0	449	0.920082	
people bt.	T1	486	0.995016	

Hiiumaa (between 5-95%)

Characteristic	**Code**	**1- values**	**Percentage**	**Comment**
port	T4	10	0.054348	
turnover k4	T202	10	0.054348	
population over 100	RA4	11	0.059783	
timber or lumber industry	T14B	11	0.059783	
art, music	T29	11	0.059783	
catering (summer)	T6C	12	0.065217	
store	T3	14	0.076087	
natural protection area	T22	14	0.076087	
coastal fishing	T42	16	0.086957	
population 50-100	RA3	21	0.11413	
farming	T7	22	0.119565	
beach	T15	22	0.119565	
retired 10-50	P2	24	0.130435	
children10-50	L2	27	0.146739	
sights	T16	28	0.152174	
accommodation	T6A	31	0.168478	
population 1-10	RA1	45	0.244565	
summerhouses	T23	62	0.336957	
working-aged 1-10	TE1	73	0.396739	

working-aged 10-50	TE2	84	0.456522	(0, 1) weak influence
population 10-50	RA2	96	0.521739	(0, 1) weak influence
children 1-10	L1	106	0.576087	(0, 1) weak influence
retired until 1-10	P1	129	0.701087	
children bt.	L0	140	0.76087	
retired bt.	P0	157	0.853261	
working-aged bt.	TE0	171	0.929348	
people bt	T1	174	0.945652	

Let us analyze the attributes of Hiiumaa and Saaremaa separately. With the π_{01}-weight function there is no variability for 50% of the attributes, with the π_1-weight function the variability is strong. As the π_1-weight function (chart of activities) is more sensitive in 50% of the region and the π_{01}-weight function in correspondingly 20% and 80% of the region, it justifies the need for two weight functions. Only attributes the value of which is mostly zero or one do not create variability. The list in Table 8 depicts attributes between 5% and 95%. These are population indicators, settlement turnover and some social and activity indicators which vary somewhat on islands.

In the case of each weight function the groups of most wide-spread social indicators appear. Both clearly separated point groups in Figure 22 have been formed by social and demographic data, which are the most important socio-economic characteristics in the settlements of Estonian islands.

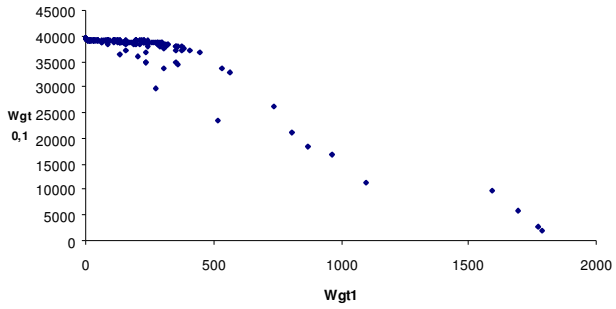


Figure 22. Distribution of the attributes as compared to the weight functions π_{01} and π_1 on the conformity scale.

On the Conformity Scale of the activities chart (in Figure 22), taking into consideration both pulling and pulling-pushing, one principal group of activities is clearly outlined – all major point groups of social indicators can be distinguished from this: the most segregated group

both on the pull scale and on the push scale is the group of indicators confirming the presence of certain social indicators (presence of people, presence of working-age people, presence of children, presence of retired people in the settlement). The second clearly distinguishable group contains the most wide-spread social indicators (for example, number of population 10-50, number of working-age population 10-50, number of retired population up to 10, children up to 10 etc.) and the presence of vacationers in the settlement. All the economic indicators and less popular social indicators are gathered together into one large group (Figure 22). On the π_1 weight function scale more typical and untypical indicators can be distinguished, which in turn point to the most typical activity indicators of the island (the most untypical for the computing system itself) (Figure 22). The factors heaped up into a large group in the figure contribute very little to determining the structure of settlements on the island.

A large dense group of attributes on the Conformity Scale on the basis of their internal structure is also divided into smaller groups, which can be distinguished by that how many settlements these apply to: a group of indicators applicable once or in one settlement, twice or in two settlements, in three, four etc. The internal or fine structure of the associations is clearly outlined in the analysis of the Monotone Systems in the minus technique, which is depicted in Figure 23.

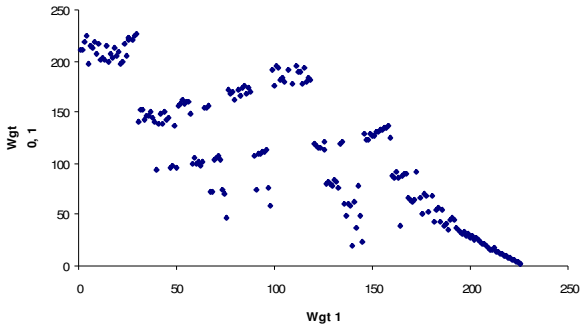


Figure 23. Fine structure of indicators distribution analysis of the Monotone Systems in the minus technique.

Hierarchical position of the settlement system is determinated by approximately 25 (23 in Saaremaa; 27 in Hiiumaa) variables from 254 or 9.8% in Estonian islands (Table 8). The most essential ones are demographic data, like number of people, children etc. Significant are also leisure activities, summerhouses, port, warf, coastal fishing, beach, hostel or camping, shop, sights. Economical affairs do not have any importance, except farming and turnover of the

settlements: in Saaremaa turnover must be over one million Estonian kroons, in Hiiumaa over half a million.

In summary, the most popular places have added value indeed, which is primarily the presence of other people in the settlement. People need, as Barker (1968) states, kind of population or presence of other people in the place. By use of the Conformity Scale and the Monotonic Systems techniques the relationship between social relations and similar elements and attributes were identified. This is verified also by the law of gravitation known from social physics, which was used in the author's master's thesis "*Mapping of the socio-spatial organization of coastal areas of Hiiumaa and Läänemaa*": the places where people already live or already prefer to take vacation or "where there is, some more is added" are attractive.
Value adding attributes were vacationers and holiday activities. Traditional activities are related to holidaymaking patterns. Also, agricultural activities can be distinguished, primarily in Saaremaa, and the related settlement patterns could be distinguished from other traditional activities, at least on the level of villages.
The same groups of attributes were identified as with the Monotone Systems as well with the FCA concepts.

6. Discussion.

As referred to in the chapter "The theoretical conceptions" this research has its roots in two interrelated traditions: the cognitive mapping that is usually traced to the work of Lynch (1960, 1995), and environmental meaning tradition that grew out of the studies of Barker's behavior setting theory (1968). From various studies in this tradition, there is a wealth of information about the way to define the different groups in different places and their structure. There may be several perspectives, like individual and communal initiatives.

The institutionalization of the sense of place through the heritage policies may also enhance the degree of dissonance that can exist between communal and individual perspectives on place and time. By virtue of this comes an immediate practical question: What is the local identity that is being sought and how can it be recognized? It should be stressed that there is no explicit mentioning in the policy documentation of any national stereotype of landscapes whose local manifestation is to be sought. If it is assumed that the country is a palimpsest of localities which are defined by some common collective identity, then that poses the same question as does the collective memory: is this an aggregate summation of a myriad of individual identities or something quite separate and plausibly different? There are contrasts between societies, as for example in the Netherlands and Northern Ireland. The Netherlands seems to suggest a model of comfortably nesting identities, ranging in size from the single individual to the largest collectivity applicable, whereas Northern Ireland suggests that conflict models are more relevant.
The Dutch model is similar to the Estonian islands' model because the difference that in our conditions dichotomy occurs between different social groups. This research is based on the geographical theories of Paulus Huigen and Louise Meijering (2005) (6).
We can see that the concepts pronounced by Huigen and Meijering interacted and are related to each other. The concept of place as a social construct appears the most important.

(1) The social construction idea (the first concept) that a settlement is determined by human relations was also a result deduced in our research where a nonlinear analysis identified social indicators as the most important ones. The settlements have been grouped on the basis of social (demographic) indicators. The idea of the social construction is accompanied also by cognitive characteristics which characterize human relations: friendly places attract people, similar attracts similar (vacationers' villages, youth villages etc.).

It seems that people with similar interests form social constructs.
Estonian islands have social barriers between the vacationers and local people. People with dissimilar background have few contact points, patterns rarely coincide: vacationers' villages and local people's settlements are mostly different. There is also an age differentiation among local population: young *versus* old people's villages.
We started our research actually as a regional social and economic research in the small territories. As a result of the study (both the Monotone Systems and the Formal Concept Analysis) it turned out that settlements are determined by people and social networks created by them. Key factors are social and demographic indicators as well as some cognitive factors (the above-mentioned friendliness etc.) that were not discussed in this analysis but are planned to be studied in the future.

(2) The second concept insists that actors link the attainment of their goals to the perceived features of the place through the place identity. The actor´s identity is based on the distinguishing features of the place, which are often considered as characteristics and identity markers. The characteristics of the spatial environment can also be seen as features of the place: vacationers´ villages, local blue-collar workers housing space, agricultural and economic villages. All they have different "face": in the popular summer villages people favour the beach, identity of the economic settlements is conditioned by economic indicators, etc.
Thus, place identity is based on the characteristics of the place, which are measurable with our formal information processing system. The idea of the methodical and technical part of our research was to supplement that kind of research by an information processing system analyzing multidimensional data, which enabled us to process a relatively large amount of different multidimensional characteristics simultaneously. We can easily explain which of them are most important for the place identity. On the basis of the attributes the subjects of concepts or groups of places with a similar identity or classification were identified in the process of the Monotone Systems and the Formal Concept Analysis. By the Monotone Systems methods both linear and nonlinear relationships between the indicators and between the objects themselves were identified.
Places groups that carry the same identity according to the Monotone Systems and the Formal Concept Analysis are as follows:
A: the most non-typical villages, with no residents;
B: villages with no children;

C: vacation villages;

D. youth villages, where a group of young people identified themselves with the given place;

E. multifunctional places: large settlements and administrative centers;

F: main group, which can be divided into three subgroups according to demographic and some economic attributes.

The most typical places in Estonian islands (whole systems views), housing places are

- economic villages;
- agricultural villages
- developed vacation villages with extra values and a strong place identity.

Vacation villages have usually some of traditional activities, like marine activities or some additional value, like beach, natural value area, etc.

The classification has been built on a number of multidimensional attributes. Our network is a 254-dimensional network, where 254 is the number of inputs of different variables. For simplicity, we have methods to look at 2-dimensional networks in the scatterplot and their represention on the maps.

In the same way we can find the key factors, which have great influence on the future development of the places.

As cognitive characteristics will be examined separately in some later works by us, then in this work we have used a number of characteristics that are either visible to the eye (nominal features, some social indicators) or measurable by numerical parameters (demographic indicators, economic and enterprise indicators). A significant share of development determining characteristics is the presence of a particular kind of qualities. On the basis of these qualities we could distinguish: growing business villages, agricultural villages in Saaremaa and summer holiday villages in Saaremaa and Hiiumaa. An important group of characteristics for determining development is summer holiday activities, including fishing opportunities, which, on the other hand, is a traditional activity on the islands. Hence, a significant share of the characteristics is derived from the past. It can be summarized as the third concept.

(3) The third concept insists that place identity is largely based on the characteristics of the place, as it was perceived in the past. Another important group of value adding attributes were

vacationers and an opportunity for holiday making. Traditional activities are related to holiday making patterns.

The other three concepts cannot be discussed separately from the previous ones, and these are also interrelated. They are important lead the debate and relativeness to the study of behavior places, i.e. dependence on different points of view and/or context.

(4) The fourth concept argues that every society is composed of different actors with different goals, who therefore attribute different identities to a place. This means that place identity is always open to debate. Actors who are powerful in terms of authority and/or resources can impose their dominant place identities at the expense of other actors. Different actors will always attribute different identities to a place. It is therefore advisable to refer to place identities in the plural.
That the identity of the place was debatable was most evident in Hiiumaa. The settlement system in terms of hierarchy has not yet fully developed, but is under transformation in Hiiumaa, which was clearly expressed in the administrative functions of both central (leader) and traditional villages.
It cannot also be assumed that there is one single identifiable collective place identity. Society is diverse and these many diversities will result in equally diverse place identities. Like the sense of time transformed into heritage, the user creates place identity.

(5) In the fifth concept, Huigen and Meijering identified at least two contexts. (i) The first is the spatial context or location, which can also be labelled as a classical socio-geographical term situation. (ii) The second context is the socio-cultural context, which consists of the prevailing norms and values of the society. This includes social and economic circumstances and relationships as well as spatial planning trends to the structure and function of places.
On the one hand, geographical location added value to places in both Saaremaa and Hiiumaa, e.g. location at sea (although we used only landing places of boats, or whether there is a beach or not, as characteristics); on the other hand, popularity of the place in general and/or among social groups with different background was determined by the social context of the place, which again was based on kind of cognitive value judgements, which we plan to study also in the future. Old collective farm settlements, available urban housing space, e.g. Taaliku in Saaremaa, Emmaste in Hiiumaa, are inhabited by blue-collar workers, and despite that both have an open view to the sea (such a view is quite rare on wooded islands), these are no

popular spots among vacationers. The collective farm inheritance and socio-cultural context also play some role here.

(6) The sixth concept states that in the context of dynamic life the communities of the both islands and their identities are in a process of constant change and are not static entities capable of being frozen at a particular moment in time.

The study of Hiiumaa identifies an active transformation in the settlement system, development of place identity. Places are populated by different social groups (people with different social backgrounds for whom this place has a different significance.

The places are in dynamic development, which in this study can be seen on the management functions and commensurate charts in the part of "case studies".

Huigen and Meijering (2005) mentioned unexpected events and developments which are thereafter balanced by the evolutionary process as an important factor in addition to evolution that influences the identity of the place. In the Estonian community as a whole, unexpected developments have played a significant role since the beginning of the 1990s and places on the islands have experienced unexpected developments during the last 17 years, which could be particularly sharply perceived in the settlement system in Hiiumaa where many settlements have not found their specific place. As my studies of the islands have proceeded since the mid-1990s, my observations involve a recession from the collective-farm-period agricultural cultivation to untilled fields and a new recovery from untilled fields to neat meadows and pastures thanks to the European Union funding of agricultural projects. Agriculture is becoming ruralized again (called as a green land-use).

Agriculture experienced a period of the economic expansion in the Soviet time whereby commercial operations became disconnected from the physical and social rural environment. Agribusiness grew away from the rural context. This phenomenon is referred to as the deruralization of agriculture.

Currently, a process of ruralization is taking place and the relationship between agricultural commerce and the rural context is being re-emphasized. This illustrates that place identity is a process, its sixth aspect. The physical environment is also important in terms of nature conservation and recreation.

Some sharp changes were noticed in the development also in connection with nature protection and in the case of Kõpu National Park in 1999-2003. In 2004, when the author focused on her articles about business life in Hiiumaa and Saaremaa for an enterprises' TOP collection of the business newspaper *Äripäev,* the main subject of the studies was people.

From among social indicators examined, in addition to other items, the educational level of local people was studied, which in Hiiumaa was much lower than in Saaremaa.
This may be a reason for the strongly debatable identity of places in Hiiumaa and the case of Kõpu peninsula national park in 1999-2003 where indigenous population, who had a relatively low educational level, did not value their home place, but vacationers[6] from outside the island came to revalue this. This was quite an elite community for Estonia and some of vacationers settled permanently in Kõpu peninsula. The newcomers identify themselves already with the Kõpu peninsula.

Despite some points of contact (in the form of central places and some local services) local people and vacationers live their separate lives on the islands. There is an above-described dichotomy: vacationers' *versus* local people's places (despite that local population in Saaremaa has a relatively high educational level) although the valuable living environment of islands and their cultural identity help people who have gone away to retain their connection to their home place.
Local people have also been differentiated: old people's *versus* young people's villages. In connection with deruralization, during the past 60 years young people moved away from villages to urbanized collective farm settlements or towns. Only older people remained to live permanently in rural villages. This tendency lasted still in the 1990s and therefore many places died out. In the 2000s, so-called youth villages started to develop, either from local forward-looking young people and/or new inhabitants who identify themselves with this place and wish to live with their household in a clean environment and nice scenery.
Island people have jobs on the island, their unemployment rate is only 5.9-6.5%, although in Hiiumaa 33% of the employment is provided by the state or the public sector. Most of the others are subcontracting workers in small plastic factories. Tourism is playing a major role in business life in Saaremaa – the culture of tourist services has developed well and the identity of Saaremaa as a tourist region sells well.
Hiiumaa is also a summer holiday region; many summer homes and cottages have been established there, but tourism does not actually play a significant role in the business life in Hiiumaa.

[6] Vacationers in Hiiumaa are wealthy people in terms of Estonia, who are quite free in their activity, as traveling to Hiiumaa is expensive and time consuming for an average Estonian, including local people of Hiiumaa.

Environmental protection gives an additional value to the place in both islands. This is the possible reason why natural protection is related by recreation areas and green land-use. Green land-use also shows some influence of the prevailing socio-cultural context. In our view, there are indicators that the most obvious place identity for the Estonian islands in the future will be an area of recreation and green land-use. This is based on the arguments from the results of previous analysis. The most important characteristics among the economic characteristics are indicators of recreational activities. Growing pressure of the vacationer to the islands' everyday life is considerable.
In social terms, decaying or already decayed villages were identified, which in geographical (environmental) terms are regarded as green areas or open space.

In consequence, place identities are constructed and reconstructed. Which place identities and development scenarios are likely to dominate the future of the Estonian islands?
According to the non-linear analysis we have indicated that five place identities and scenarios apply to the area: (1) developing summer vacation villages and recreation areas, (2) decaying and decayed villages, so-called undeveloped areas or green areas (open space).
(3) hidden urbanization (people live urban life style in the rural areas), different sized settlements for local population (housing space), (4) central places with many economic activities, and (5) ruralization and green land-use (farming as a horse and sheep husbandry).

Our methodology supports the semantic theoretical considerations and contents. Our novel information processing methods have been successful as they helped to identify the hidden dimensions and the structures, even in the form of human relocation trajectories and road networks notwithstanding that we had them not included into the respective data for processing. The the influence of nominal features can be measured by our methods and nonlinear relations of the multidimensional data can be identified

Though investigations have indicated that earlier presence of other people is important for settling, the selection criteria obviously include also some cognitive factors that will be studied in the future. These tendencies occur in different ways both among local people and among vacationers.

In this research functions which were based on the Monotone Systems' Minus Technique were used as a method of analysis, which can and will be used to measure **the social position**

of a settlement in the system. From the aspect of this research a settlement system is a social organization which has a hierarchy. Our research demonstrates that the hierarchical network of settlements is important for local people, but it is not very important for vacationers on the islands. On the other hand, natural seaside and other places that carry one's equals are important for newcomers, in consequence, they attract new people who expect to experience something pleasant, or" where there is some more added".
Therefore the settlement system of islands should be examined rather as a system working as a network which has a hierarchical structure. Hierarchical position of the settlement system is determinated by approximately 25 attributes from 254 for Estonian islands. The most essential ones are demographic data.

In summary, the most popular places in Estonian islands have indeed added value, which is primarily the presence of other people in the settlement. People need, as Barker (1968) states, kind of population or presence of other people in the place. By the Conformity Scale and the Monotone Systems techniques the structured relationship between social relations and similar elements and attributes was identified. In addition, this is also verified by the law of gravitation known from social physics.

7. Conclusion

The concepts pronounced by Huigen and Meijering are interrelated. The statement that a settlement is determined mostly by human relations has been also proven in this research, where a nonlinear analysis identified social indicators as of highest significance. The settlements were grouped on the basis of social (demographic) indicators. The idea of social construction is accompanied also by cognitive characteristics which characterize human relations: friendly places attract people, similar attracts similar (vacationers' villages, youth villages etc.).

In the future cognitive characteristics will be studied in more detail, but in this research a number of characteristics which are either visible to the eye (nominal attributes, some social indicators) or measurable by numerical parameters (demographic data, economic and enterprise indicators) were used. An important development determining group of attributes was holiday activities, including fishing, which, on the other hand, is a traditional activity on the islands.

Hence, a significant share of the characteristics has been derived from the past: the above-mentioned fishing, landing places for boats, as well as agricultural land and agricultural activity traditions. Nature protection today is possible only on the areas little used by people or which have been used nature-protectively; economic activity in old economic settlements etc.

Map drawings show that there is a dichotomy and social barrier between the vacationers and local people. They have few contact points, patterns rarely coincide: vacationers' villages and local people's settlements are different.

In the main, vacationers and local people have no significant contacts; their activities and social networks rarely coincide. Vacationers (primarily newcomers) don not settle in locals' villages, for example, in spite of the open sea view. These factors based on the study seem to be important. In particular, the analysis results of Saaremaa stand out where vacationers form a separate concept, moreover, the map shows that as compared to local social networks, quite different places are important. The survey results in Hiiumaa confirm the same tendency, but they are not so sharply distinctive in the results of analysis.

There is also an age or life span differentiation among local population: young *versus* old people's villages. It seems that people with similar interests form social constructs. Thus, the

”architecture“ of the settlements is also the frame of social relations, as reported by Doreen Massey (2002).
Identity in both Estonian islands is based on the people and the dichotomised community, along with culture of the local people and the vacationers and the landscape. In Hiiumaa the observable situation was not so clear, because the analysis of Hiiumaa identified a transition of the settlement system and the development of the identity of places. The identity of places in Saaremaa seems to be established according to our analysis; however, in the study period a directions of continued further stable development along with the societal development were observed.

The application of the Monotone Systems for the analysis of socio-economic data in the small functional territories in Estonian islands was successful. As a result, the hidden dimensions and structures were identified, even in the form of human relocation trajectories and road networks notwithstanding that the respective data were not included for processing. The purpose of this research was achieved: to identify the structure of hidden social relations, germs of new structures and social development nuclei, places with a strong identity which are still fortifying their identity. At the same time, in social terms, decaying or already decayed villages were also identified, which in geographical (environmental) terms are regarded as green areas or open space.
In addition, the central places with secure position have been separated.

Our methods require merely a discrete data table and they are formally based on intuitively computationally simple weight functions that describe objects “typicality” for the data table. Use of two slightly different weight functions allows us to create two-dimensional conformity plots visualization for multivariate social-economical data. As similar elements have similar weights, it is possible to find groups of similar settlements forming a socio-economic classification of the settlements.

As the π_{01} system depicts a whole, activities are few in the whole picture and we presume the local everyday activity and social network can be identified. Overall, a conclusion is that the weight function π_1 identified mostly purely functional relationships. The hierarchy of settlements was identified with the weight function π_{01}. Activity indicators (π_{01} system) for both islands also coincided: in most typical villages in Hiiumaa only vacation related

activities were dominating. The most typical villages could be divided on the basis of activities into three groups: vacation villages, economic villages, and agricultural villages. Most of the typical island villages with human activities are located by the sea, and the islands are historically-culturally engaged with marine activities, which today are valued again, and a settlement is traditionally concentrated by the sea, which is particularly contrasting in Hiiumaa where the inland is quite deserted.

The settlement system in Saaremaa is already established, as there are many settlements with a similar weight and attributes, settlement groupings coincide on the basis of both of these weight functions.

The settlement system in Hiiumaa is still under development or in the phase of transformation, since regrouping of the settlements is still in progress and the attribute values were different in each function, places have not yet a definite position in the system and their further development is somewhat unclear.

As by the functions (π_{01} and π_1) different aspects of settlements were identified, then in terms of grouping the best results can be obtained if the results the above-described weight functions are compared by combining the two functions into one generalizing map.

As a result of the comparison of functions, on the chart all possible linkages based on whether the ”events“ take place (existence of indicator) or not; and in these conditions the main group is formed of points (settlements) with the same or similar attributes. Major settlements were separated from the main group because of the multitude of activity indicators (small number of zeros) – and the pattern characterizing the settlement system of islands is clearly outlined.

The major concepts calculated by the FCA, coincide with the point groups found in the Conformity Scale. Similarly to the conformity analysis, large settlements, holiday villages, economic villages, agricultural villages and housing villages with different social indicators form separate concepts. Hence, the Formal Concept Analysis supported this research both for testing and for the analysis of content.

We could separate the core surroundings of economic development for Kuressaare (Saaremaa) and Käina (Hiiumaa). Self-contained concepts have been formed by the holiday villages, economic settlements, agricultural villages and living places (housing space). Even on the map (Figure 13) the lines of the road can be recognized, despite the commensurate data not entered in the information processing.

Management functions enable us to separate all active places and create a hierarchical system for the settlements. It shows us developmental ranking of islands villages.
More powerful settlements attract also villages with better social indicators where nothing significant happens besides living and holiday spending. Therefore, there is a clear difference between settlements: more active and simultaneously more viable ones pull towards activity; villages and places with lower social indicators where there is no activity, including some peripheral villages of larger settlements, towards incompetency.

Hierarchical position of the settlement system is determinated by approximately 25 attributes from 254 or 9.8% in Estonian islands. The most essential attributes are demographic data.

We can therefore conclude that our non-linear data analysis methods support the geographical theoretical considerations and contents and some important viewpoints.

We have several advantages using the new information processing methods worked out in TUT:

- No knowledge of relationships between the data is required in advance.
- Data will be totally separated (impossible to affect the results).
- Different kinds and amounts of data and data from different categories;
- Computationally a fast method;
- New information in the graphs (and maps);
- Discovering (linear and non-linear) linkages between data;
- Concepts classification;
- Hierarchical classification or information in queue of gravity and significance (using the management functions);
- Eventuality to discover development (active) areas;
- Context maps, disclosing hidden structures and deep semantics.

The most important fact is that the analyses by the Monotone Systems methods identified both linear and non-linear relationships between the indicators and between the objects themselves to disclose the hidden relations and invisible social structures.

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Sotsiaalsete struktuuride kaardistamine formaalsete mittelineaarsete infotöötluse meetoditega:

Juhtumiuuringud Eesti saarte keskkondades

Lühikokkuvõte

On tähtis tunnustada arusaama, et uute mittelineaarsete infotöötlusmeetodite abil on võimalik süvendada maailmatunnetust ja arendada edasi integreeritud, distsipliinideüleseid, suhteliselt laiapõhjalisi sotsiaalseid ning geograafia-alaseid uuringuid, mis vastaksid nüüdisaegse teaduse ja ühiskonna nõudmistele, avastades süvasemantikal põhinevaid uusi teadmisi.

Miks kujunevad välja sotsiaalsed struktuurid? Inimesed usuvad, et saavad nende läbi oma eesmärke efektiivsemalt realiseerida. Et olla ja tegutseda, tuleb olla keskkonna mingis Paigas.

Paiga identiteet ei ole paiga loomupärane osa, vaid see on seotud inimestega. Sotsiaalsete suhete rägastik, ajalooliselt kujunenud sotsio-kultuurilised tähendused ning inimeste igapäevane elu teevad paigast selle, millisena teda tuntakse ning määravad tema ülesehituse.

Paikade ja inimeste identiteetide vastastikune põimumine (*construction*) on pidev protsess. Inimeste suhted paikadega muutuvad, muutuvad paigad ning nende tähendus inimeste jaoks.

Nagu ütleb Doreen Massey (2002), on asulate „arhitektuur“ ühtlasi sotsiaalsete suhete raamistikuks. Sotsiaalsete suhete ruum on konstrueeritud, nagu on ehitatud majad, need võivad kohanduda, nagu majad on kohandatud. Sotsiaalsed suhted ei ole küll materiaalsed, nagu on majad, kuid läbi sotsiaalsete barjääride võib olla raskem kõndida kui läbi seinte. See on mittemateriaalne arhitektuur – sotsiaalsete suhete konstruktsioon. Seal kus toimivad sotsiaalsed suhted, leiab väljundi ja materialiseerub sotsiaalne praktika. Paigad on sotsiaalse praktika materialiseerumise tulemus.

Käesolevas dissertatsioonis arendan ma edasi peidetud sotsiaalsete suhete ideed igapäevaelu keskkondades. Inimeste tegevus on üldiselt koondunud sotsiaalsetesse struktuuridesse. Sotsiaalsed struktuurid on üheks olulisemaks teguriks paiga identiteedi kujunemisel, mis ühelt poolt võimaldavad ning teisest poolt piiravad inimese aktiivsust ja vabadust teha valikuid.

Ühiskonna, sealhulgas kogukonna areng toimub läbi sotsiaalse süsteemi ja inimsuhete.

Kasutan juhtumiuuringutena Eesti saarte (Saaremaa ja Hiiumaa) igapäevaelu keskkondi. Sellistel väikestel territooriumitel paistavad näiliselt peidetud sotsiaalsed suhted välja, mis aga tõstatab küsimuse, kuidas need nähtavale tuua ja kaardistada. Selleks tuleb leida informatsiooni töötlemise süsteemid, millel endal puudub sisemine semantika ja võimaldavad .ühisesse mõõtsüsteemi viia ka nominaalsed väärtused ning tuvastada mitmemõõtmeliste andmete mittelineaarsed seosed. Kõige sobivam selleks on formaalsed infotöötlussüsteemid, mis töötlevad ei-jaa tüüpi andmeid.

Mul oli hea võimalus testida L.Võhandu ja J.Mullati (1976) poolt Tallinna Tehnikaülikoolis väljatöötatud Konformismiskaalat ja Monotoonsete Süsteemide tehnikaid (pluss ja miinus tehnikaid). Kuna Konformismiskaala ja Monotoonsed Süsteemid identifitseerivad elementide ja atribuutide tuumikuid, moodustades ontoloogilisi raamistilkke, otsustasime lisaks testida ka maailmas kasvavat populaarsust omavat sakslaste Wille, Canteri ja Stumme (1992, 2005) poolt väljaarendatud Formaalset Kontseptide Analüüsi (Formal Concept Analysis, FCA), mis nagu tema nimigi ütleb, jagab elemendid ja atribuudid vastavateemalisteks kontseptideks. Nii formeeruvad erineva identiteediga asulate grupid, mis baseeruvad sisestatud atribuutidel ehk tunnustel ning teevad võimalikuks elementide klassifikatsiooni.

Suur hulk erinevast kategooriast näitajaid teevad standartsete statistiliste andmeanalüüsi meetodite kasutamise ruumilises, majanduslikus ja sotsiaalses uuringus äärmiselt raskeks. Monotoonsete süsteemide meetodid, FCA areng ja levik annab uue visuaalse analüüsi platvormi andmekaeve (*data mining*) ja uute teadmiste avastamise (*knowledge discovery*) tarbeks, mis tegeleb mitmemõõtmeliste andmete analüüsi ning sotsiaalse käitumise ennustamisega, süvasemantika ja sisemiste seoste identifitseerimise, andmete klassifitseerimise ja visualiseerimisega.

Meie meetodil on rida eeliseid, milleks olulisemad on arvutamiskiirus, segatüüpi andmete kasutamine ning see, et tulemusi ei saa mõjutada, mis aga võimaldab leida uut informatsiooni. Meie meetod nõuab vaid diskreetset andmetabelit, baseerudes arvutuslikult lihtsatel kaalufunktsioonidel, mis kirjeldavad objekti „tüüpilisuse“ järgi antud andmetabeli jaoks.

Minu eesmärk on välja pakkuda äärmiselt huvitav Monotoonsete Süsteemide ja Formaalse Kontseptianalüüsi elementidest kombineeritud meetod uuenevale geograafiateadusele, mis teeb võimalikuks avada peidetud ja nähtamatud struktuurid looduslikes ja sotsiaalsetes keskkondades. Peidetud reaalsuse avamine, sotsiaalsete struktuuride ja arengut määravate tegurite identifitdseerimine on ka minu teaduslik ülesanne käesolevas dissertatsioonis.

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Curriculum vitae

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3. Education

Educational institution	Graduation year	Education (field of study/ degree)
Tartu University	2000	M.Sc in geography

4. Language Skills (basic, intermediate or high level)

Language	Level
Estonian	High level
English	Intermediate
Russian	Basic
Finnish	Basic
German	Basic

5. Professional Employment

Period	Organisation	Position
2008-…	Tallinn University of Technology	lecturer
2003-2008	Tallinn University of Technology	Research and teaching assistant
2001-2002	EKI	GIS specialist
1997-2000	REI	engineer

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Torim, A.; Lindroos, K. (2008). Sorting Concepts by Priority Using Theory of Monotone Systems. *In: LNCS: ICCS'08 - Conceptual Structures: Knowledge Visualization and Reasoning, 7-11 July, Toulouse, France.* Heidelberg: Springer-Verlag, 2008. pp. 175-188.

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7. Defended Thesis

   Mapping of the socio-spatial organization of coastal areas of Hiiumaa and Läänemaa, M.Sc (geography) **Tartu University**, 2000

8. Research Interests

social structures and constructions, social networks, social network analysis, information visualization, data mining and knowledge discovery, conformity scale, non-linear information processing, monotone systems, deep semantics, ontology, behavior places, human spatial behavior (behaviorism), spatial patterns, clustering, social physics, cognitive mapping, conceptual structures, formal concept analysis, environment, etc.

Curriculum vitae (in Estonian)

3. Isikuandmed

Ees- ja perekonnanimi: Karin Lindroos

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3. Haridus

Õppeasutus	Lõpetamise aeg	Haridus (eriala/kraad)
Tartu Ülikool	2000	M.Sc geograafias

4. Keelteoskus (alg-, kesk- või kõrgtase)

Keel	Tase
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Inglise keel	kesktase
Vene keel	algtase
Soome keel	algtase
Saksa keel	algtase

5. Teenistuskäik

Töötamise aeg	Asutus	Ametikoht
2008-…	Tallinna Tehnikaülikool	lektor
2003-2008	Tallinna Tehnikaülikool	assistent
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1997-2000	REI	insener

9. Teadustegevus (sh. publikatsioonid)

Torim, A.; Lindroos, K. (2008). Sorting Concepts by Priority Using Theory of Monotone Systems. *In: LNCS: ICCS'08 - Conceptual Structures: Knowledge Visualization and Reasoning, 7-11 July, Toulouse, France.* Heidelberg: Springer-Verlag, 2008. pp. 175-188.

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Juurikas, Karin;Purju, Alari;Pädam, Sirje;Rõbakova, Jelena (2004). Keskkonnaökonoomika : õpik. Tallinn: Tallinna Tehnikaülikooli Kirjastus, pp. 184.

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Juurikas, Karin (2004). Hiidlaste ja läänlaste igapäevaste liikumiste kaardimudelid. Akadeemia, 6, 1383 - 1396

10. Kaitstud lõputööd

Mapping of the socio-spatial organization of coastal areas of Hiiumaa and Läänemaa, M.Sc (geograafia) Tartu Ülikool, 2000

11. Teadustöö põhisuunad ja teaduslikud huvid

Sotsiaalsed struktuurid ja konstruktsioonid, sotsiaalsete võrgustike analüüs, informatsiooni visualiseerimine, andmekaeve ja uudse teabe avastamine, konformismiskaala, mittelineaarsed infotöötluse meetodid, monotoonsed süsteemid, süvasemantika, ontoloogia, käitumispaigad, inimeste ruumiline käitumine (biheiviorism), ruumilised mustrid, klasterdumine, sotsiaalne füüsika, kognitiivne kaardistamine, kontseptaalsed struktuurid, formaalne kontseptianalüüs, keskkond, etc.