QUALITATIVE MODELING AND MONITORING OF THE SELECTED ECOSYSTEM VIOLATED BY PARASITIC DEHUMIDIFYING AND DEHYDRATING

Jiří Bíla
Structure of Presentation:

- Introduction
- Small (Short) water cycle and its violation
- Map of measurement centers and monitoring system
- Qualitative description - states, super classes and matroids
- Applied methods and Results
- Future research
- Conclusions
Figure 2  Třeboň Biosphere Reserve. Cultural landscape with artificial lakes – fish ponds. Photo J. Ševčík.
In the mentioned ecosystem is evaporated water quickly brought up in the zone in which does not condense yet and in this height zone is transported outside the ecosystem to distanced mountains where spontaneously condenses in rising air streams.

- Reasons:
  - The overheating of the landscape surface and the air above the surface.
  - The increased transport velocity in non condensation zone (with one prevailing direction).
INTRODUCTION

DAILY INPUT OF SOLAR ENERGY
6 kWh.m²

0 - 1000 W.m²

flux

HEAT
up to 60%

EVAPOTRANSPIRATION
10 - 20%

REFLECTANCE
10 - 35%

DRAINED LANDSCAPE

HEAT FLUX TO THE SOIL
5 - 10%

LANDSCAPE SATURATED WITH WATER

HEAT FLUX TO THE SOIL
5 - 20%

REFLECTANCE
5 - 15%

HEAT
5 - 10%

EVAPOTRANSPIRATION
up to 80%

10 - 20%
Small (Short) Water Cycle and its violation

- Precipitation
- Evaporation
- Short water cycle
- Water infiltration
- Surface outflow
- Groundwater level
- Subsurface outflow
- Long water cycle transfer
- Short water cycle
- Long water cycle
- Short water cycle
- Ocean
- Land
Violation of Short Water Cycle

Open water cycle

Long period without rain

High temperature amplitude

Water–unsaturated soil

Dehydration of landscape

High discharge of water and dissolved matter
Standard Short Water Cycle

Closed water cycle

Frequent less precipitation

Low temperature amplitude

Water-saturated soil
Low dissolved matter flow
Accumulation of organic matter
Even water discharge
Map of Measurement Centres and Monitoring System
Method of the Description and Monitoring

Classical approach: “Bottom-Up”
- Measurement (22 measurement centers in the monitored landscape) and processing of results → mathematical models

Qualitative approach: “Top-Down”
- State description and analysis of state dependencies → state models and inferences from state models and from additional constructions (Hasse diagrams and matroid bases).

Monitoring:
- Supervising of standard behavior of ecosystem,
- Detection of abnormal and unexpected situations,
- Prognosis of ecosystem behavior in near future.
Qualitative Approach - Overview

Basic phases:


2. Construction of matroid on the set of system states → construction of matroid bases → interpretation of associated variables on matroid bases.
Qualitative Description - States

Monitoring States:

Air humidity and water
S1… Low local humidity, S2… Middle local humidity, S3… High local humidity, S4… Local fog, S5… Region fog (covers the area larger than 20 km²), S6… High volume of water soaked in the soil, S7… Local floods, S8… Violence of the small water cycle (SWC),

Weather
S9… Rain, S10… Snow, S11… Long time local dry atmosphere, (arid soil), S12… Semi-clear weather, S13… Very cloudy weather and overcast, S14… Strong wind, S15… Storm,

Evaporation
S16… High evaporation (no water goes back down the surface), S17… Middle evaporation – (a part of evaporated water goes back to places of evaporation), S18… Low evaporation, S19… Violated evapotranspiration.
## Qualitative Description - States and Transitions

### Qualitative Matrix of Transitions

<table>
<thead>
<tr>
<th></th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
<th>S5</th>
<th>S6</th>
<th>S7</th>
<th>S8</th>
<th>S9</th>
<th>S10</th>
<th>S11</th>
<th>S12</th>
<th>S13</th>
<th>S14</th>
<th>S15</th>
<th>S16</th>
<th>S17</th>
<th>S18</th>
<th>S19</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>1</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>S2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>*</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>*</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>S3</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>*</td>
<td>*</td>
<td>0</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>S4</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>*</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>S5</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>*</td>
<td>*</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>*</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>S6</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>*</td>
<td>*</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>*</td>
<td>*</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>S7</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>S8</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>S9</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>S10</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>S11</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>S12</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>*</td>
<td>*</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>S13</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>0</td>
<td>0</td>
<td>*</td>
<td>*</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>*</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>S14</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>0</td>
<td>0</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>S15</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>S16</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>*</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>S17</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>*</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>S18</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>*</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>*</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>S19</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
Qualitative Description - Super Class
A1. Moist Extreme of SWC
Qualitative Description - Super Class
A2. Dry Extreme of SWC

Diagram:
- S1
- S2
- S9
- S14
- S15
- S19
- S11
- S8
Qualitative Description - Super Class

A3. Stabilizing behaviour of Ecosystem

S1

S18

S15

S9

S4

S5

S2
Qualitative Description - Super Class
A4. Standard behaviour of Ecosystem
• The complete behaviour of the ecosystem is done by the State diagram (Qualitative matrix of the state transitions) and by the transitions between super classes.

• There is extracted a higher dependence on the set of super classes.

<table>
<thead>
<tr>
<th>( M_G )</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>( A_0 )</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>( A_1 )</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( A_2 )</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>( A_3 )</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( A_4 )</td>
<td>1</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
Monitoring of Ecosystem and the Detection of Unexpected situations

- The formal dependency between super-classes is constructed by data mining method (by Hasse diagram approach) as a table of associated rules.

- An unexpected situation violates a rule in the table.

<table>
<thead>
<tr>
<th>Rule No. $i$</th>
<th>Rule $r_i$</th>
<th>Supp($r_i$)</th>
<th>Conf ($r_i$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$A_1 \Rightarrow A_4$</td>
<td>0.33</td>
<td>0.66</td>
</tr>
<tr>
<td>2</td>
<td>$A_1 \Rightarrow A_3$</td>
<td>0.33</td>
<td>0.66</td>
</tr>
<tr>
<td>3</td>
<td>$A_2 \Rightarrow A_4$</td>
<td>0.165</td>
<td>0.5</td>
</tr>
<tr>
<td>4</td>
<td>$A_2 \Rightarrow A_3$</td>
<td>0.165</td>
<td>0.5</td>
</tr>
<tr>
<td>5</td>
<td>$A_3 \Rightarrow A_4$</td>
<td>0.33</td>
<td>0.5</td>
</tr>
<tr>
<td>6</td>
<td>$A_1 A_4 \Rightarrow A_3$</td>
<td>0.165</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>$A_1 A_3 \Rightarrow A_4$</td>
<td>0.165</td>
<td>1</td>
</tr>
</tbody>
</table>
Monitoring of Ecosystem and the Detection of Unexpected situations

• The *unexpected situation* is detected as the declination from behavior of ecosystem determined by system of the rules. Such dangerous rules are, e.g.:

\[ \{A_1 \Rightarrow A_2, A_2 \Rightarrow A_1, A_3 \Rightarrow A_2, A_3 \Rightarrow A_1, A_4 \Rightarrow A_3\} \].

These rules indicate some abnormal situation which is not considered in the dependency (and which has never been observed yet).
Construction of the Matroid and Inferences from its Bases

- Construction of qualitative matrix of dependent relation,
- Extraction of bases,
- Interpretation of associated variables on matroid bases.
# Construction of Qualitative matrix of the dependent (DNT) relation

## Qualitative matrix of DNT relation

<table>
<thead>
<tr>
<th></th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
<th>S5</th>
<th>S6</th>
<th>S7</th>
<th>S8</th>
<th>S9</th>
<th>S10</th>
<th>S11</th>
<th>S12</th>
<th>S13</th>
<th>S14</th>
<th>S15</th>
<th>S16</th>
<th>S17</th>
<th>S18</th>
<th>S19</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>S2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>S3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>S4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>S5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>S6</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>S7</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>S8</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>S9</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>S10</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>S11</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>S12</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>S13</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>S14</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>S15</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>S16</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>S17</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>S18</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>S19</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Four 5 elements bases there were extracted.

\[ B_1 = \{ S_2, S_7, S_{12}, S_{14}, S_{15} \} , \]
\[ B_2 = \{ S_2, S_7, S_8, S_{12}, S_{15} \} , \]
\[ B_3 = \{ S_4, S_7, S_{12}, S_{15}, S_{19} \} , \]
\[ B_4 = \{ S_7, S_{10}, S_{12}, S_{14}, S_{19} \} . \]
Interpretation of Associated variables on Matroid Bases

Let us consider a nonnegative real function $h: X \rightarrow \mathbb{R}^+$ that assigns states $S_1$ – $S_{19}$ to real numbers. According to known theorems - at least one of the discovered bases $B_j$ concentrates highest value

$$H(B) = \sum h(S_i), \text{ proj } \in \{1,2,3,4\}.$$ 

$S_i \in B_j$

Hypotheses:
(i) $h$ is energy concentrated in states,
(ii) $h$ is information about the ecosystem

Example: Base B1: „$S_2$ (Middle local humidity), $S_7$ (Local floods), $S_{12}$ (Semi-clear weather), $S_{14}$ (Strong wind), $S_{15}$ (Storm)“
Conclusions

- Classical approach to monitoring of ecosystem (of our type) brings us lot of GB of data and much of work with processing.

- Conclusions from models extracted by classical approach are in most qualitative. Examples: No corn fields, no wasted turf fields. Vegetation yes, but not too much.

- Qualitative approach works with expert experience and enable us to overview great area of the solved problem.

- Conclusions from qualitative models would have been verified by results of measurement and quantitative models. (Future research.)

- In the presentation and in the paper (in proceedings) was proposed one line of research using qualitative methods.