Observation of Terrestrial Processes in Model High mountain Geosystems around the peaks Musala (Rila Mountain) and Vihren (Pirin mountain)

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What are terrestrial processes?

- Processes of transfer of substance and energy on Earth surface and near it
- Main agents: solar radiation, water, wind, gravity
- Additional factors: Plants and animals
- Human impact

Main terrestrial processes

- Weathering
- Mass movement (denudation)
- Accumulation

Observation of terrestrial processes in the context of global change

- **Geosystems**

Environmental complexes on a territory where all nature components interact in a specific way

- **Geosystem parts:**

-Atmospheric
-Hydrosperic
-Lithospheric
-Biospheric
-Pedospheric

Observation of terrestrial processes in the context of global change

- Climate change – affects geosystems' substantial and energetic inputs
- Environmental reaction – change in the other parts
- Result – change in processes that occur in geosystems
- Importance: these changes may cause losses of natural heritage or harm to people

Global change and cold environments

- **Cold environments: places on Earth where occurrence of most natural processes is strongly predominated by frost and frost action**

  - high latitude environments: boreal forest, tundra, partly glacialed barren lands

  - high altitude environments: high mountain forest, subalpine, alpine and partly glaciated areas

Global change and cold environments

- Glacier activity during the Ice Age sharpened topographic contrasts and charged cold environments with great energy for terrestrial processes occurrence

Global networks SEDIFLUX and SEDIBUD

- **SEDIFLUX**

(Sediment Source to Sink fluxes in Cold Environments)

- Scientific network supported by ESF (2004 – 2006)

- **SEDIBUD**

(Sediment Budgets in Cold Environments)

- Scientific workgroup in IAG / AIG (2005 – 2009)

Global networks SEDIFLUX and SEDIBUD

- **Main goals:**

- to collect and to compare data and knowledge about terrestrial processes from a wide range of different cold environments
- to assess environmental reaction of these environments on global change

Global networks SEDIFLUX and SEDIBUD

- **SEDIBUD Research Strategy**

- Application of standardized methods for qualitative and quantitative analysis and research through a network of cold environment test sites all over the globe (SEDIFLUX Manual)
- Insertion of results in a common database

Bulgarian Periglacial Programme - a basic concept

- Launched in response to the need of long-term strategy of Bulgarian science in the field of periglacial researches
- Main task – to research and observe the dynamics of contemporary terrestrial processes that occur in Bulgarian cold environments
- Main goal – creation of series of landscape based periglacial environment models, which to be used for prognoses of global change, as well as for natural disasters risk assessment
- Consist of two modules:
  - Rila module (BPP Musala) – operating in the area around Musala peak
  - Pirin module (BPP Pirin) – operating in Northern Pirin .

Bulgarian Periglacial Programme - following a 50 year tradition

First observation campaign – Golemia Kazan cirque by Vl. Popov – IGY 1957 - 1959

3 year perennial snow patch observation

First high mountain science station

Bulgarian Periglacial Programme

- the project

“Models of contemporary Periglacial Morphogenesis”

-Duration – 2004 to 2006

-Colaboration agreement between IG and INRNE

-Main tasks:

- Parallel investigations of present high mountain and polar morphodynamic in 4 model areas:
  - Musala area (Rila mountain)
  - Vihren area (Pirin mountain)
  - Heard peninsula (Livingstone island)
  - Spitsbergen (Schlesian University Antarctic Base)
- Elucidation of genetic relationships between both the present morphodynamic processes and the relief;
- Age detection of forms and form complexes through quantitive analysis of morphogenetic processes;
- Elaboration of models (evolutionary and prognostic) of the periglacial morphogenesis.

Bulgarian Periglacial Programme

- the project

“Models of contemporary Periglacial Morphogenesis”

Only small part of the tasks have been performed due to severe funding restriction

Bulgarian Periglacial Programme

- the project

“Models of contemporary Periglacial Morphogenesis”

- What has been done

- research of water chemistry
  - lakes in Musala cirque (Rila mountain)
  - karst springs near Bunderica river and in Razlog field (Pirin mountain)
  - Caves in northern Pirin
  - precipitation waters in Rila and Pirin
- Investigation of Cave inlets – Kazanite and Banski Suhodol cirques (Pirin mountain)

Bulgarian Periglacial Programme

- the project

“Models of contemporary Periglacial Morphogenesis”

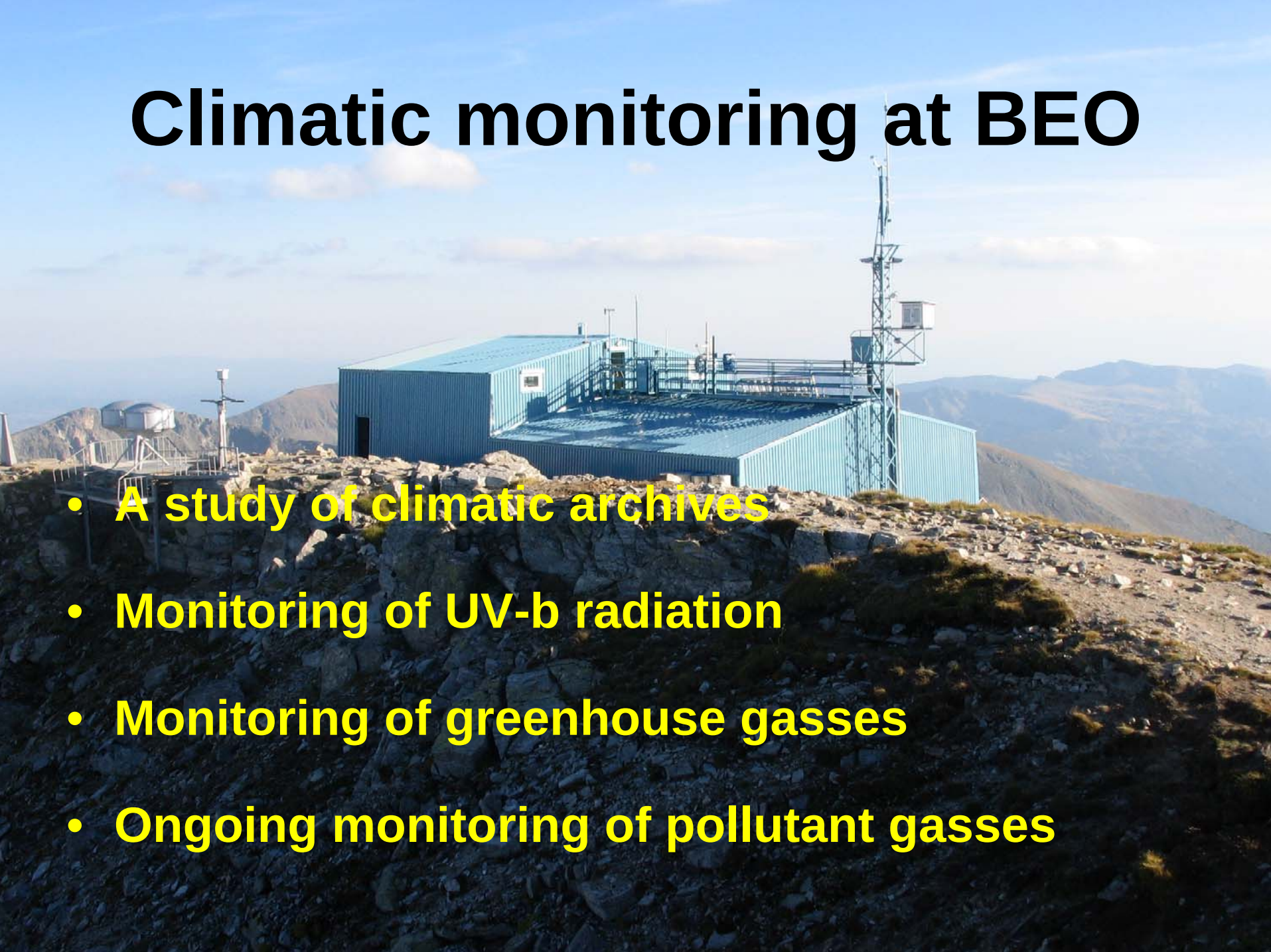
- What has been done

- Creation of a database
- Development of spatial models in GIS for Musala cirque (Rila) and Golemia Kazan cirque (Pirin)
- Detailed environmental mappings
- First terrain campaigns
- Setting up of transects for observation of terrestrial processes
  - Weathering
  - Solifluction
  - Talus movement

Future perspectives

- Widening the range of observations
- Widening the extent of module sites
- Association to global scientific structures

Climatic monitoring at BEO



- A study of climatic archives
- Monitoring of UV-b radiation
- Monitoring of greenhouse gasses
- Ongoing monitoring of pollutant gasses

SEDIBUD application

Establishment of a SEDIBUD test site in the area around Musala peak

- Selection campaign: first half of 2007
- Basic requirements:
  - Representing cold environment
  - Defined on catchment principle
  - Area between 10 and 30 km^2
  - Variety of terrestrial processes presented
  - Homogeneous lithology
  - Monitoring of basic climatic parameters on year-round basis
  - Monitoring on catchment outlets
  - Creation of spatial models in GIS
  - Project activities in field of environment and global change
  - Easy access throughout the year

The test site

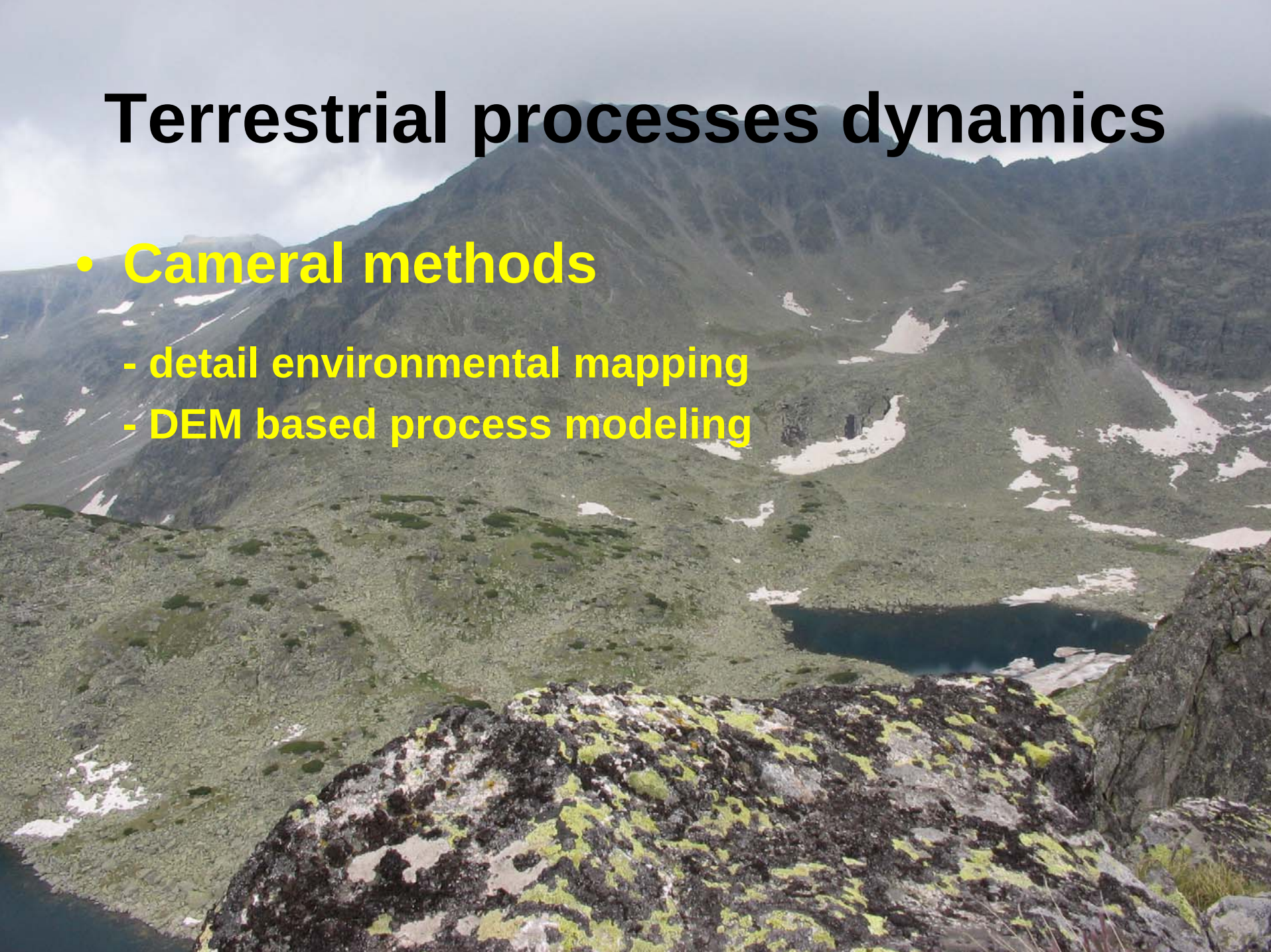
To match to SEDIBUD criteria Musala area test site should include:

- The upper part of Musala cirque (present BPP module site – 2,5 km^2)
- The lower part of Musala cirque (down to 1850 m a. s. l. – 4,3 km^2)
- Marichini ezera cirque – 4 km^2)
- The uppermost Maritsa valley (down to 1850 m a. s. l - 7 km^2)

Thus the test site will consist of two catchment subsystems which can give comparable results

Local climatic observation

- Three transects with 3 measurement points each
- Portable data loggers, placed in the field
- Measurements: air temperature, ground temperature



Terrestrial processes dynamics

- **Cameral methods**

  - detail environmental mapping

  - DEM based process modeling

Terrestrial processes dynamics

- **Automatic hydrometry measurements at catchment outlets**

  - water amount
  - conductivity
  - turbidity
  - bedload

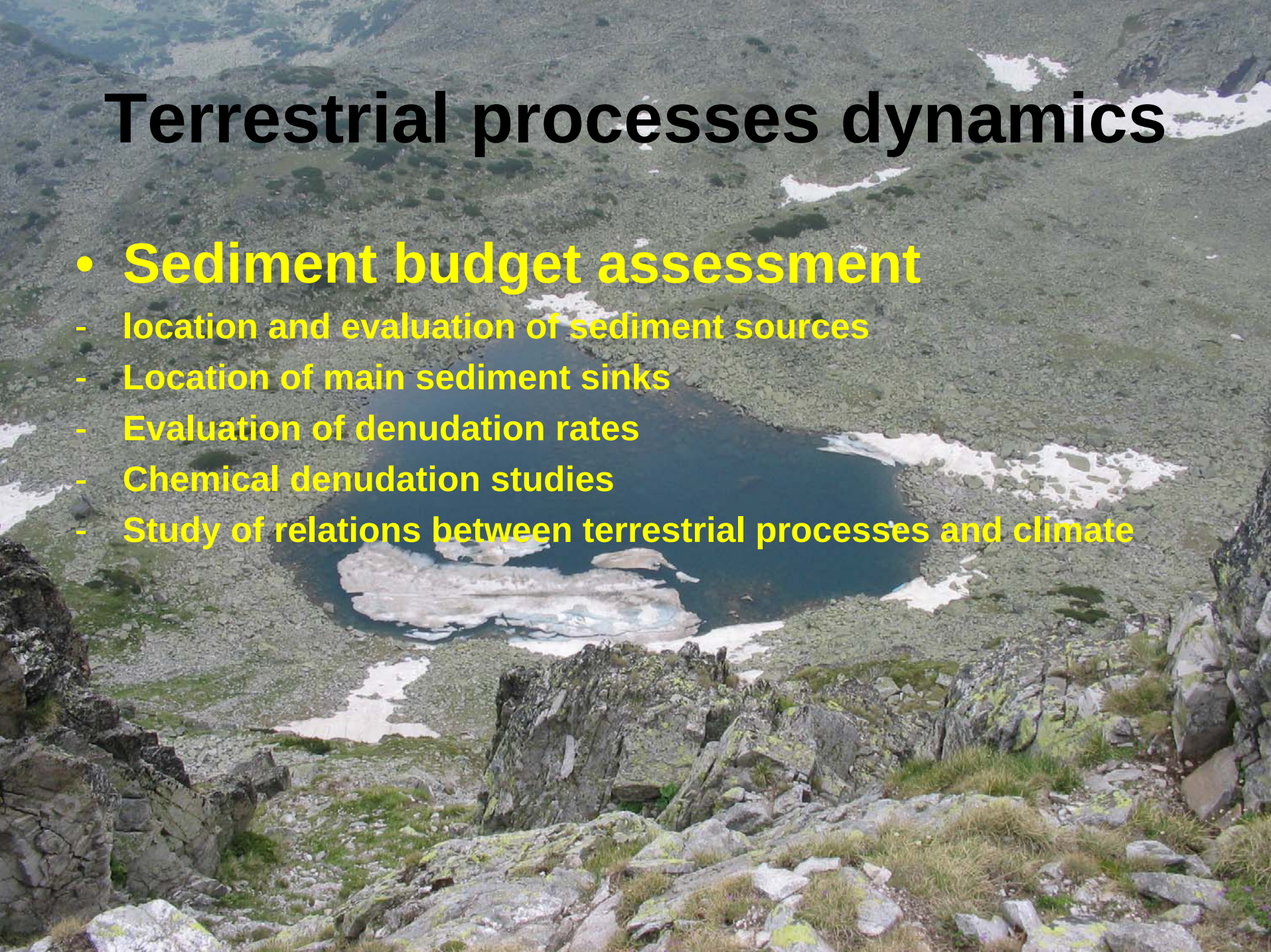
- **Other automatic measurements**

Terrestrial processes dynamics

- **Fieldwork measurements:**
  - snow cover structure and avalanche activity
  - permafrost distribution
  - weathering
  - mass movement
    - rockfalls
    - debris movement in talus and gullies
    - solifluction
    - fluvial processes (gully and river erosion)
  - subsurface mapping
  - dating of sediment deposits
  - monitoring of water chemistry

Terrestrial processes dynamics

- **Carbon cycle monitoring and global change**



Terrestrial processes dynamics

- **Sediment budget assessment**
  - location and evaluation of sediment sources
  - Location of main sediment sinks
  - Evaluation of denudation rates
  - Chemical denudation studies
  - Study of relations between terrestrial processes and climate

Assessment of human impact

- **Main aspects of human impact:**
  - **Skiing**
  - **Mountaineering**
  - **Transit pollution**

Assessment of human impact

- **Main influences on geosystems in Musala area**

- change in land cover
- Triggering of disastrous processes
  - avalanches
  - erosion
  - landslides
  - forest fires
- pollution

Assessment of human impact

- **Activities related to human impact assessment**
  - **evaluation of visitors number and its seasonal dynamics**
  - **location and classification of anthropogenized environments**
  - **assessment of risk of natural disasters that may cause harms or material losses**

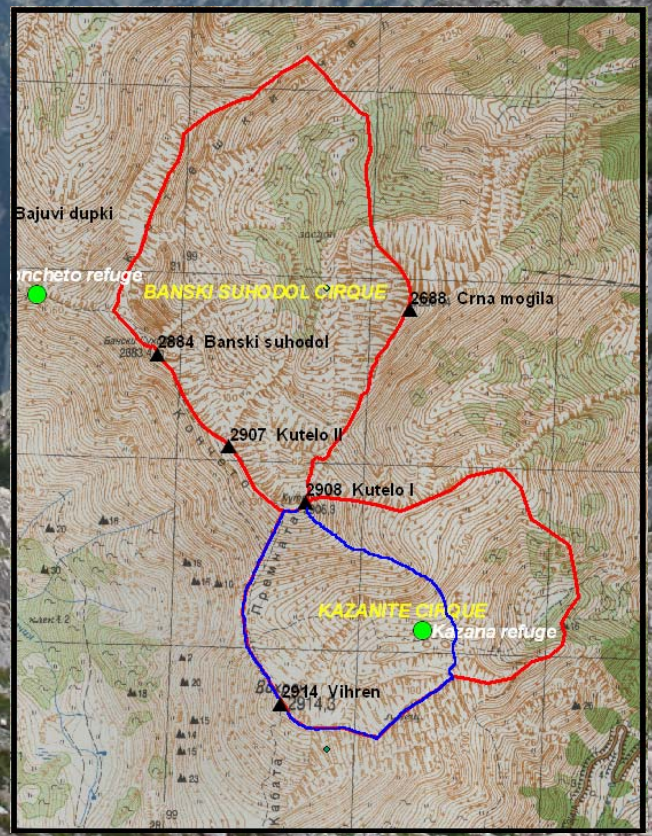
Environmental monitoring in Pirin

- BEO monitoring will cover more fully the main cold environment types in Bulgaria
- Northern Pirin represents a different cold environment where periglacial and karst terrestrial processes act together
- Monitoring data from BEO can be related to Vihren area
- Parallel research in both module sites will allow to compare different environments' reaction on global change

Environmental monitoring in Pirin

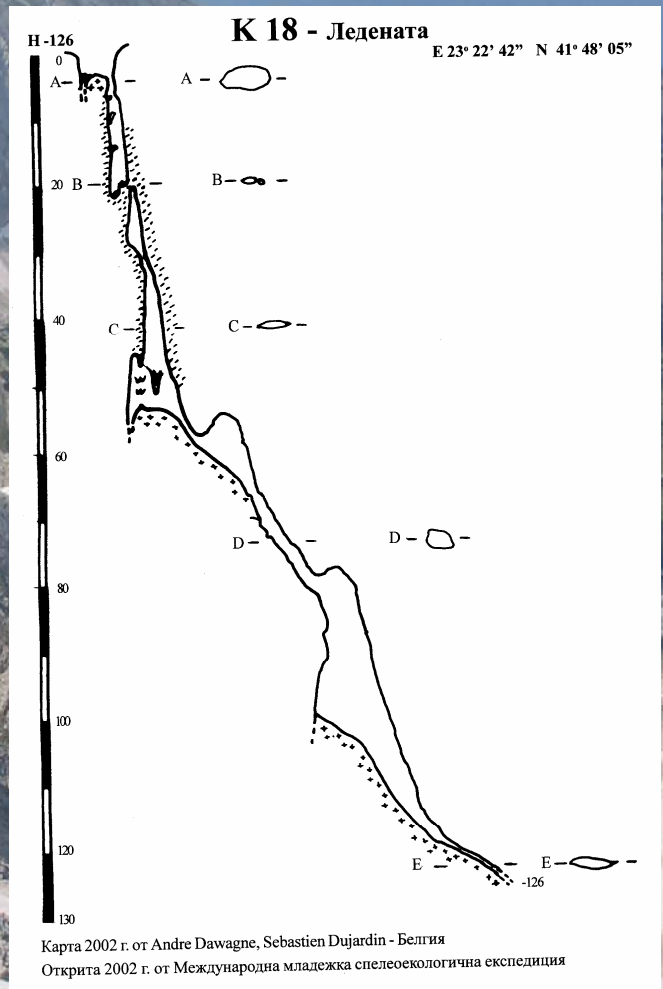
- **To be comparative, Pirin module site should include:**

- **Golemia Kazan Cirque**
- **(present BPP module site – 1,5 km²)**
- **Malkia Kazan Cirque (area 2 km²)**
- **Banski Suhodol Cirque (area 3 km²)**



Environmental monitoring in Pirin

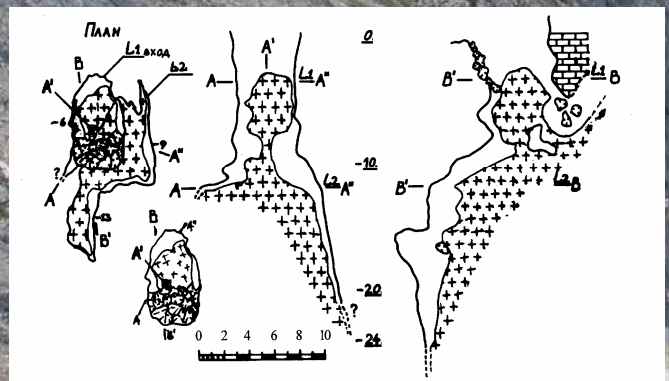
- **Main areas of interest**
  - Dating of cave permanent underground firn deposits, which are a unique “nature” calendary
  - Assessment of Global change affects on cave systems, which cause underground firn fields to melt away
  - Revealing the pattern of groundwater circulation



Карта 2002 г. от Andre Dawagne, Sebastien Dujardin - Белгия
Открита 2002 г. от Международна младежка спелеоекологична експедиция

Environmental monitoring in Pirin

- Karst processes make environmental systems more complicated and vulnerable to human impacts
- The area is part of “Pirin” national park – in close necessity to Bansko ski centre



Карта 2002 г. от Николай Орлов, Nancy Rossetti, Marilyne Hanin, на втория вход, открит 2002 г.

Открита 1983 г. от СПК “Академик”, проверена 2000, 2002

Conclusion

- Observation and research of terrestrial processes is very important for high mountain global change studies
- It should become an integrative part of BEO monitoring activities
- Establishment of a SEDIBUD test site in Musala area will strengthen the links between global research networks
- Running parallel research in Northern Pirin will allow to compare different cold environment reactions on global change, which will help to better understand the problem

Thank you for the attention

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