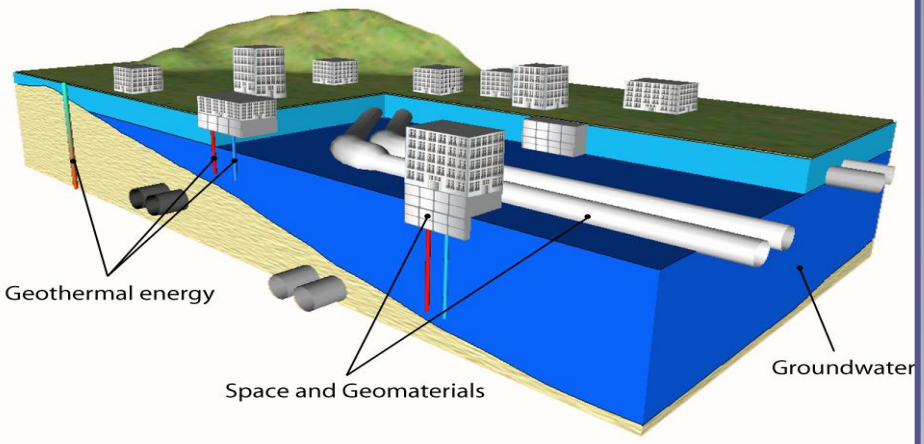


"Urban underground, a resource, a system"

Deep City Project
Comparison between Switzerland and China

A multi-use integrated approach for urban underground space planning

EPFL GEOLEP/REME
Doctoral School in Management of Technology
Mrs. LI Huanqing

OUTLINE

I. The philosophy of the concept

II. Deep City in Switzerland - a real test in Geneva

III. Deep City in China - a sustainable concept to go worldwide…

Statement of the DEEP CITY project

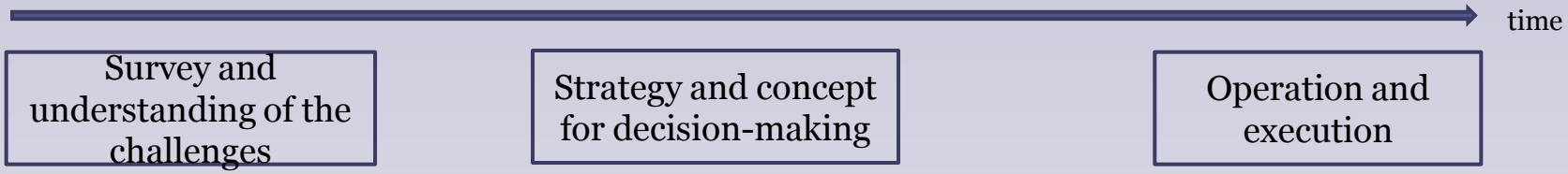
"A planned multiple-uses approach allows exploiting the full resources potential of the underground in a better sustainability" – an added value for underground use planning

Specificity of the mission

« Interface Geology – Engineering »

In great engineering projects, integration in the territory and in the environment is a key of the acceptability

General process of Planning for Territorial Engineering Project

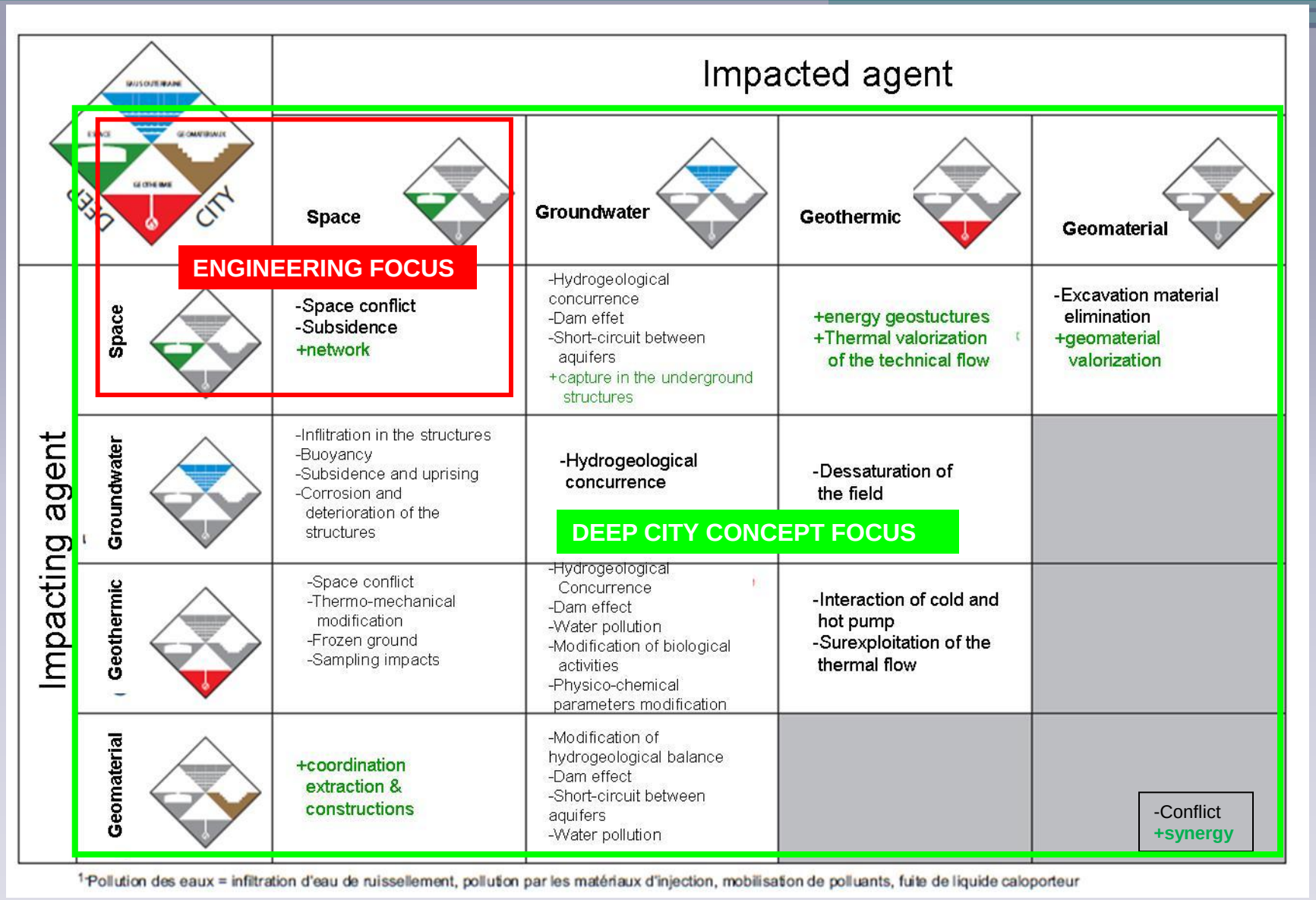


Understand the geological potentials at the initial stage of planning !

SSSTC-Sino-Swiss Science and Technology Cooperation Program

FNSNF Swiss National Science Foundation

Sustainable Development of the Built Environment
National Research Programme NRP 54



[1] Pollution des eaux = infiltration d'eau de ruissellement, pollution par les matériaux d'injection, mobilisation de polluants, fuite de liquide caloporteur

Understand the interactions between resources = Create a vision for space planning

DEEP CITY project

Work Package 1

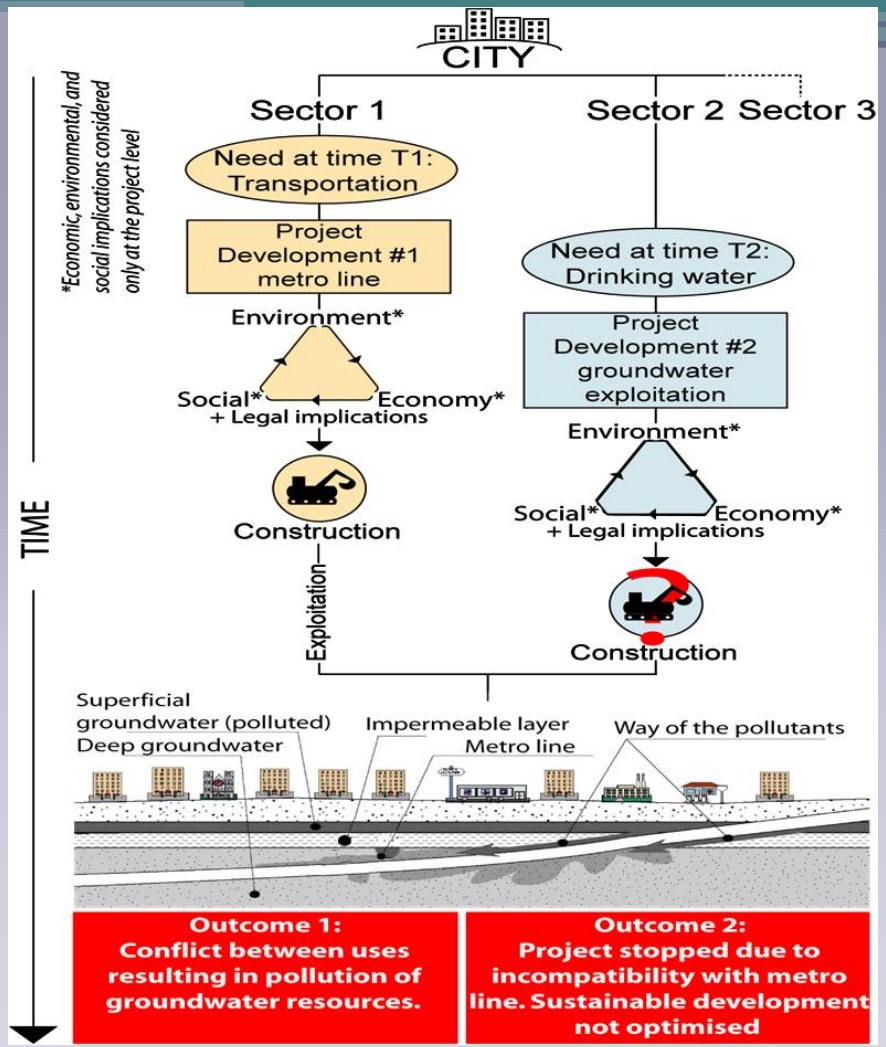
"Lessons of the past"

Five case studies:

Mexico-city, Montreal, Paris, Helsinki, Tokyo

"Sectorial approach" of urban underground use is the main responsible of the non-conformity to the principles of Sustainable Development.

Our mission:
To avoid the same problem in Switzerland and other countries



Create an underground development scenarios according to multi-use concept for main typical geological structures (including modelling and analysis of the scenarios)

DEEP CITY project Work Package 2

"Development of a new methodology"

Main Scenarios:

1. Analyze the acceptance of the society, the feasibility in the fields of ownership, sociology, economy, political acceptance, urbanism and legislation.

Why the underground resources are explored in a inappropriate way from the view of the society?

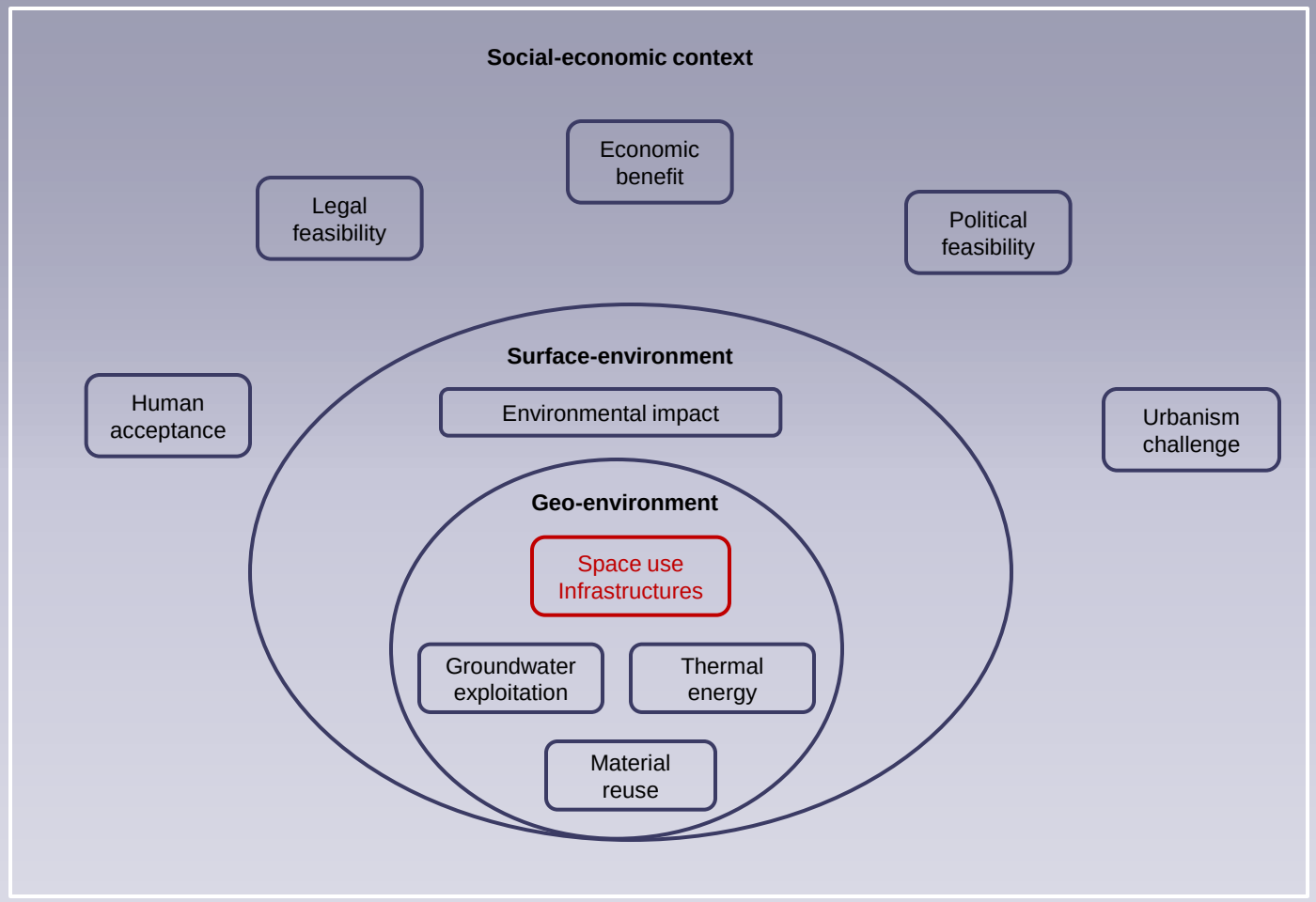
2. Develop a "Multi-use approach" for the urban underground, to understand the interactions between Space for construction, drinking water, Geomaterials and Geothermal exploitation, in order to promote the synergies and avoid the conflicts in the planning.

How to optimize the use from the view of geology?

3. Integrate a scientific framework in city Planning
   - Natural and built environment data, 3D representing models
   - Global Potential evaluations of the four resources for Multi-use, 2D evaluation maps
   - Apply the methodology into the land development projects

How to help the decision-making from the view of planning process?

TO CONCLUDE…Critical success factors in urban underground space planning



Underground management for optimal use = Underground resources integrated management

Sustainability = multi-dimensional analysis

Environment and underground infrastructure

Surface environment

Structures of junctions

Subsurface environment

resources (**energy, water, material, space**), external environment of the infrastructure

Natural support

Explore & protect

protect

Underground **space use**, by Geo-engineering ---focus on internal environment of the infrastructure

Kind of needs:

- Mass transit system
- public utility system
- Food storage & distribution system
- Water storage
- Energy storage
- Car parking, shopping center, cultural activities
- Shelters for natural disasters

Legislation and laws

Urban development

-Long-term Planning should include surface and subsurface land-use as normal parts
- National Master planning, Town planning, a basic for decision-making
- Authorities support the adaptation of laws and regulations
- Risk management (financial, geological, construction, contractual, environmental, operational)

Public acceptance

- Security aspect
- Architectural quality (visual design)
- Psychological and health aspect

need

benefit

benefit

benefit

Economic development

- Financial capacity
- Capital return and increase
- Increase market for the underground use
- Economic assessment of underground facilities : life-cycle costs; indirect benefits offered by the underground alternative

Financial support

Enhancement for economic activities

Technological development

- Civil engineering
- Communication
- Electricity
- Transportation, logistics
- Information system and 3D-data management

Technical support

(use the right data, choose the right location, apply the right construction methods)

Innovation

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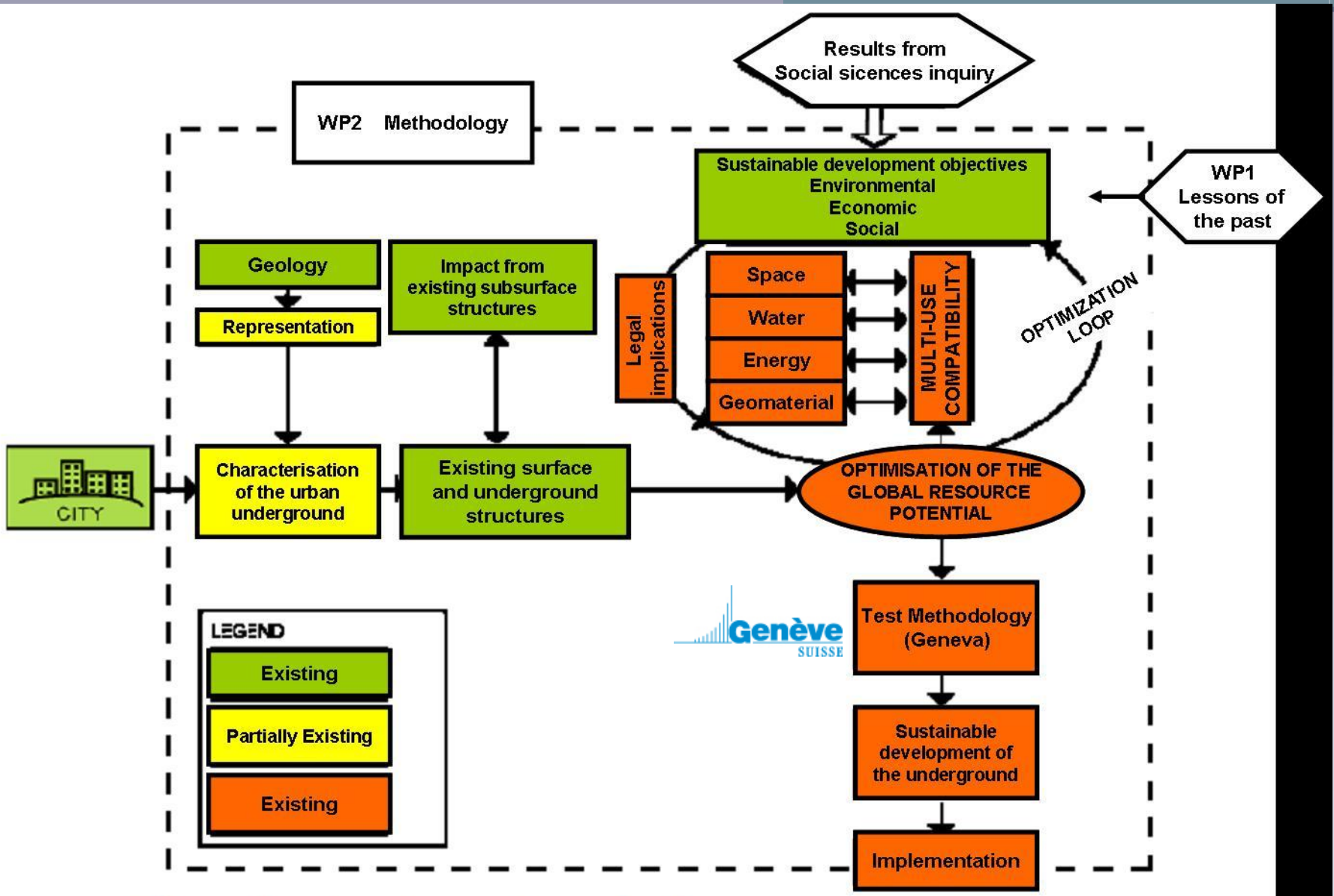
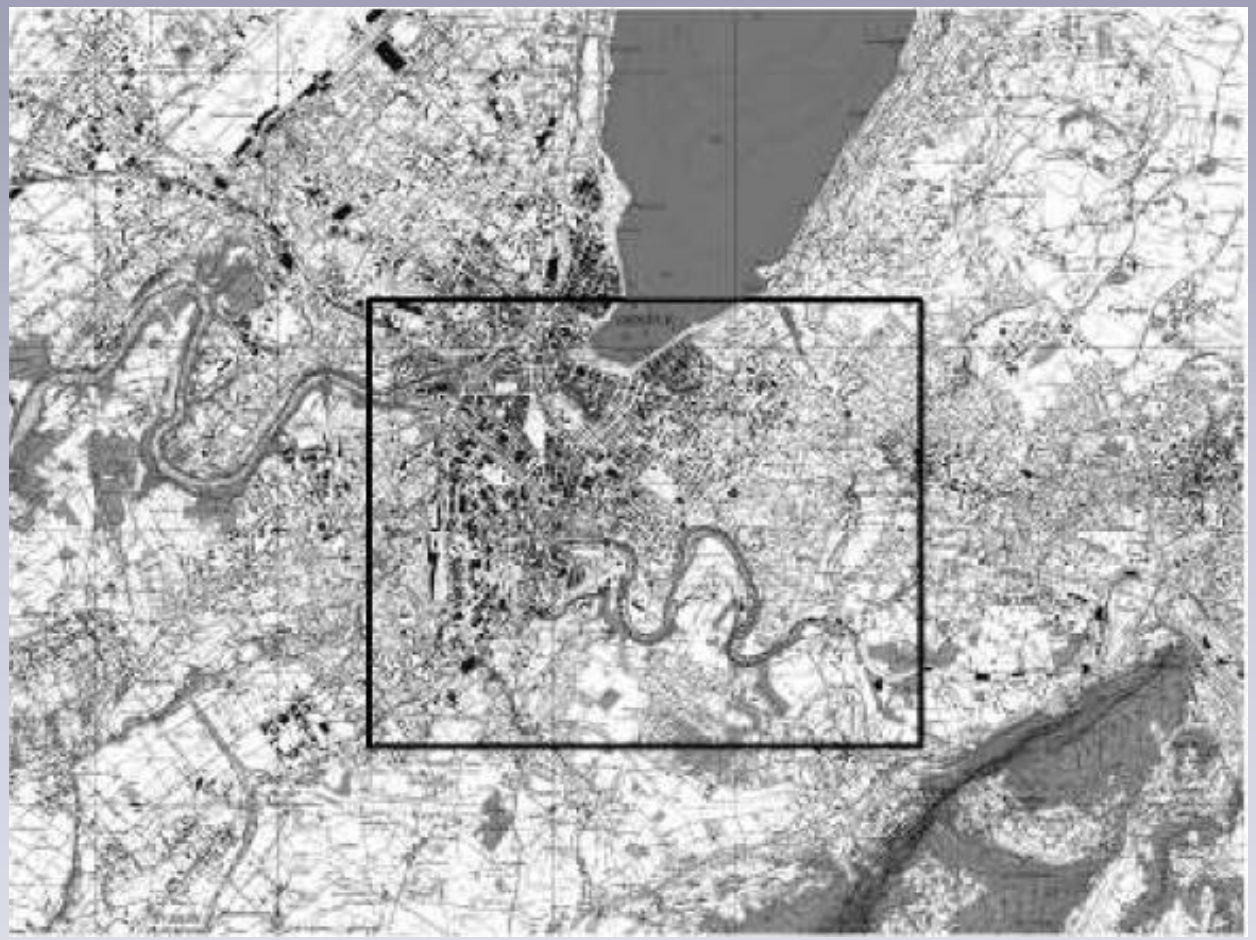
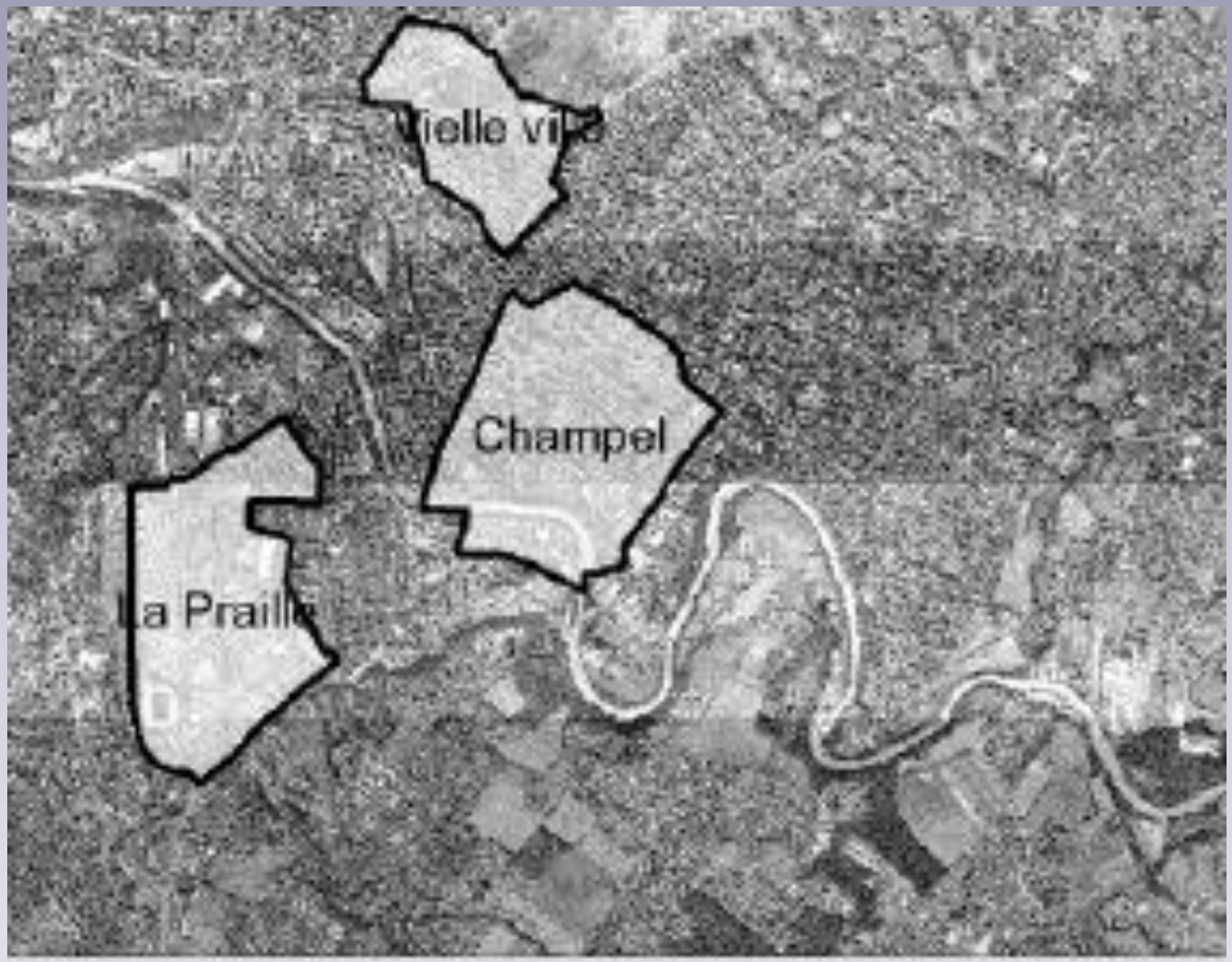


Multiuse of the urban underground for sustainable development

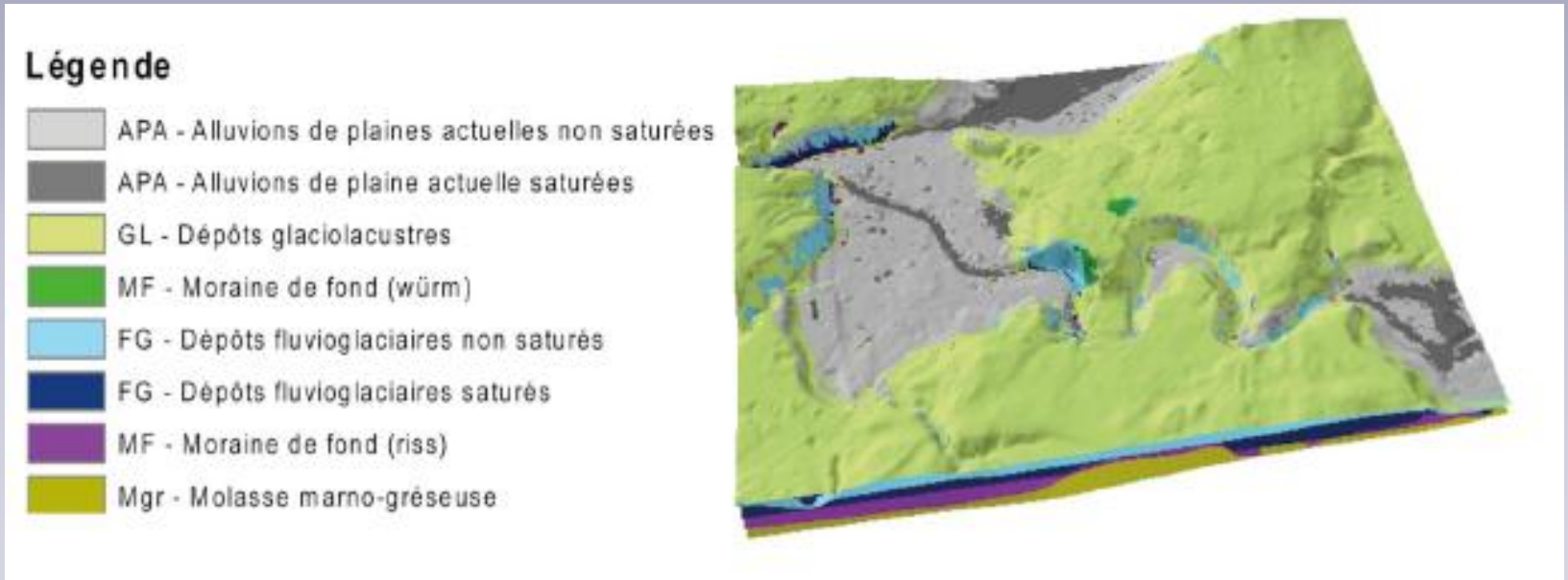
Geneva urban zone



3 zones selected for test



3D geological and hydro-geological model of Geneva City



Scenario1. Acceptance analysis :

Legal feasibility: conflicts of interest regarding land ownership, environmental protection laws for underground resources, construction project standards, need of instrument to promote multi-use potential.

Human aspect: increase public acceptance of different underground infrastructures due to quality of architecture, security issues.

Economic feasibility: underground construction in favorable geological condition saves more energy, according to a life-cycle comparison between surface and subsurface buildings.

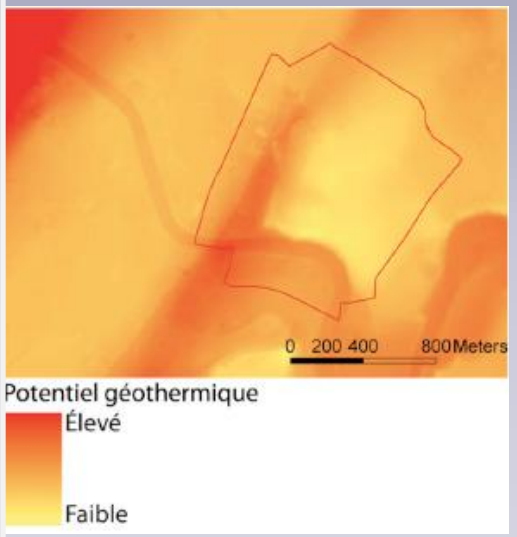
Political feasibility: opposition to a new development project of CEVA franco-genevoise tunnel, NIMBY(not in my backyard) reaction of residents in the zone of Champel.

Urbanism challenges: the need for global underground planning, incitation measures to preserve the subsurface, develop the public-private partnership and improve underground knowledge.

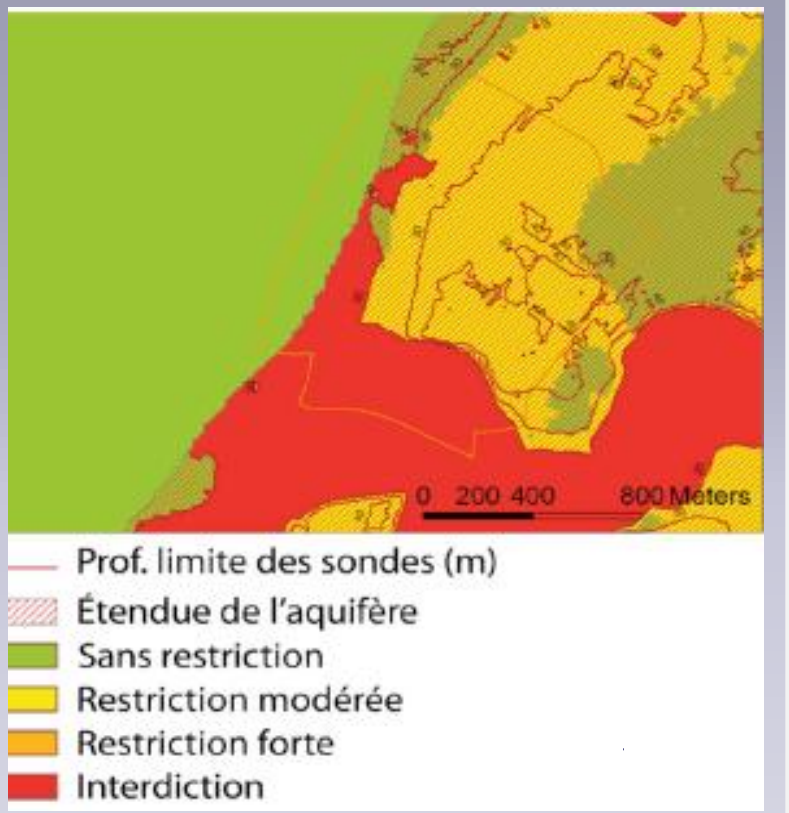
Scenario 2. Multi-use approach for underground use (Zone Champel):

A. Geostructure

geothermal probe of 150m depth



Groundwater protection



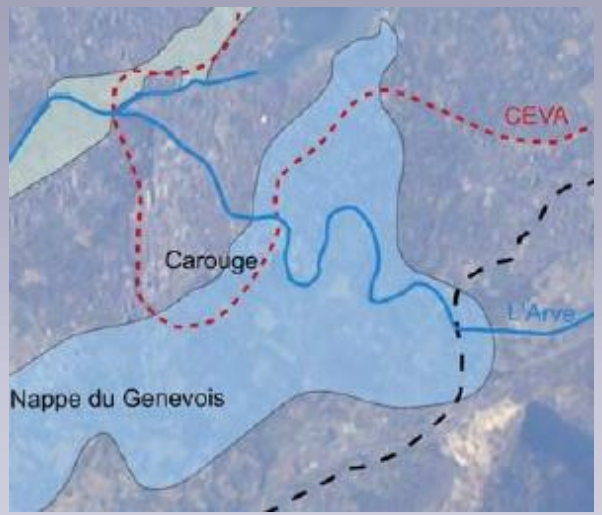
Interaction geothermic ⟺ groundwater

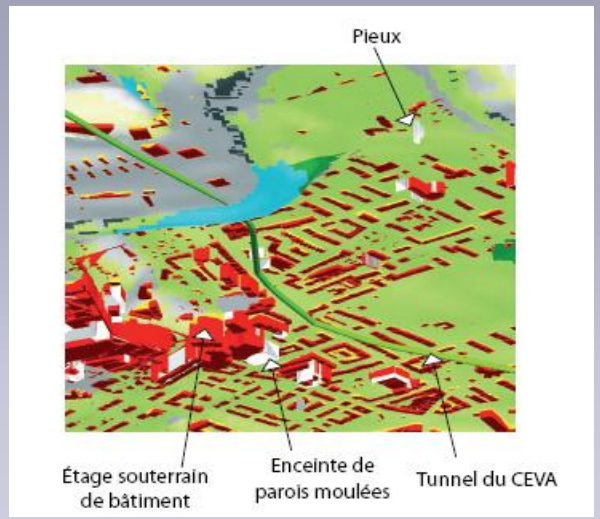
Global Potential evaluation map for geostuctures:

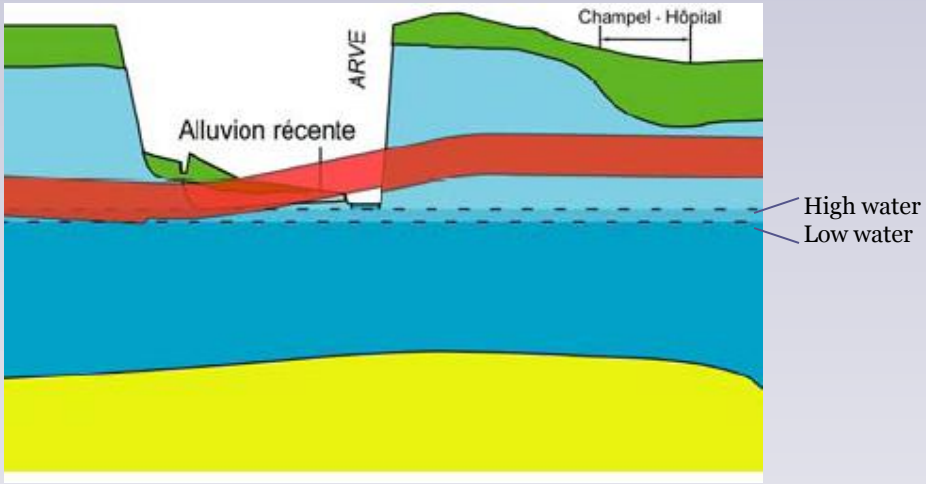
- In Champel, low potential
- **To the north-west of Champel , high potential.**

B. Cross-river tunnel

CEVA tunnel
across the river of Arve
and the aquifer Genevoise







Interaction space ⟺ **groundwater** :

-barrier-effect and short-circuit

-reducing the groundwater flow

-contaminate the portable water

Scenario 3. Integration into the city planning (La Praille):

- Zone transformation: a outworn suburb industrial zone to a central modern zone
- First Master Plan : localize business in the center with high-rise buildings (white circles)
- Later engineering projects: integrate a multi-use resources management into planning

Global diagnostic based on the classification of Géotypes:

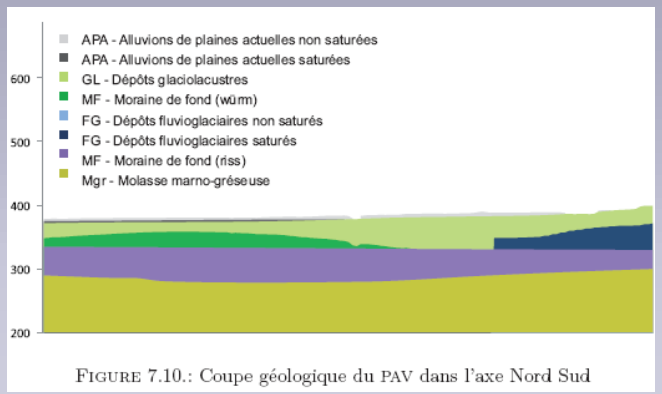
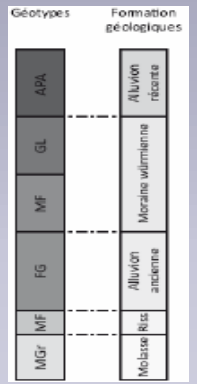


FIGURE 7.10.: Coupe géologique du PAV dans l'axe Nord Sud



Space potential : bedrock in **northern area** is more appropriate for high-rise building
Geomaterials recyclable: **high potential** to explore aggregate in construction
Groundwater use: **drinking water** in peripheral area and **industrial use** in central area, conflict with the building foundations in the center
Geothermal energy: high potential for geostructures in **northern area** (black circle)

NORTHERN ZONE is more suitable for City redevelopment

TO CONCLUDE…

Early diagnostic has to be performed before the city planning, in order to ensure the technical and environmental realism.
Challenge between underground use optimization and urban planning nowadays.

The proposition Deep City of integrating underground resources management into Swiss Federal Law of Territory Planning has been accepted and under consultation.

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Deep City Joint Research Project

Funded by Ministry of Science and Technology, China and Swiss National Science Foundation

International Partnership:

GEOLEP
Engineering and Environmental Geology Laboratory

REME Recherches en Economie et Management de l'Environnement
RESEARCH LAB ON THE ECONOMICS AND MANAGEMENT OF THE ENVIRONMENT

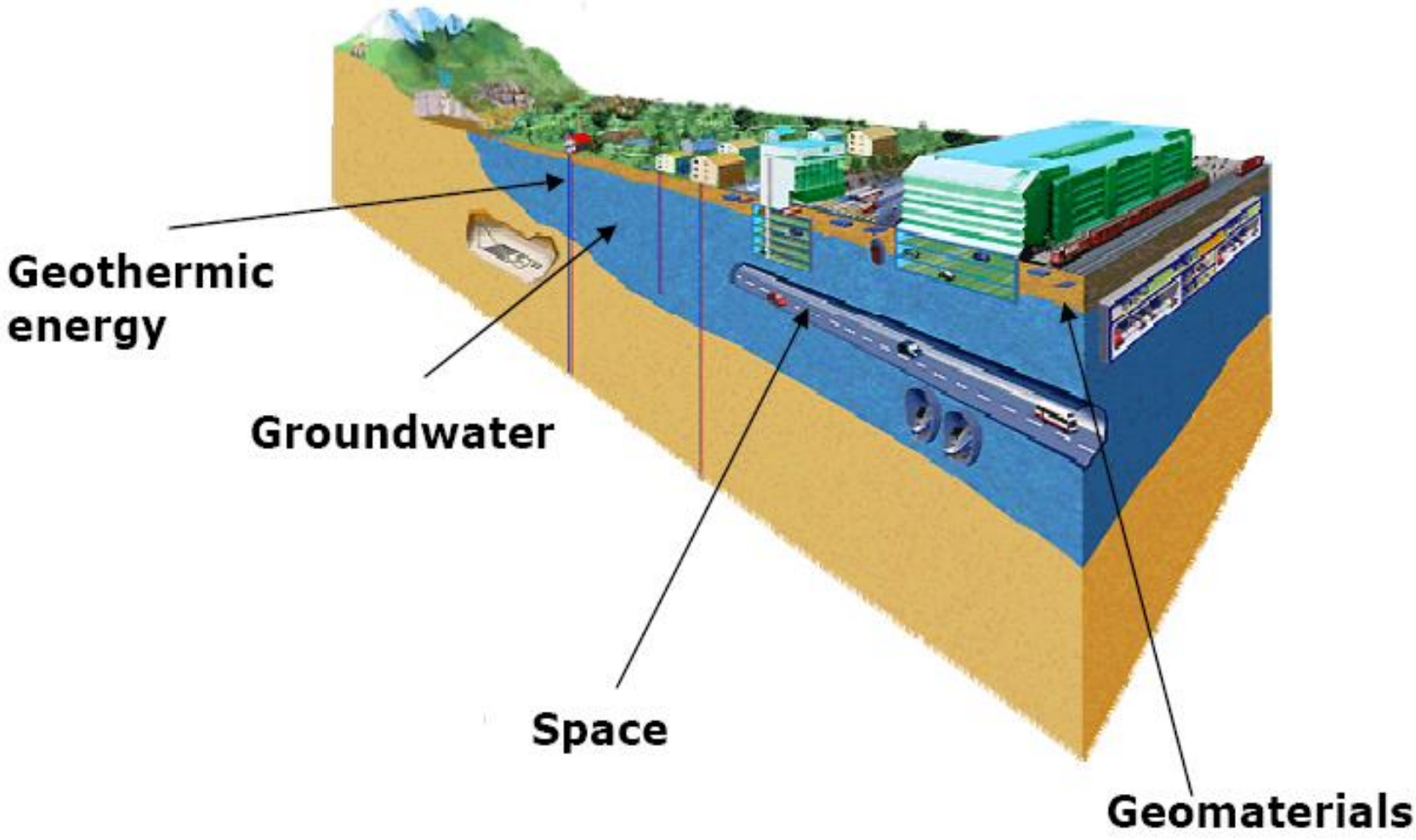
EPFL
Swiss federal institute of Technology, Lausanne

NANJING UNIVERSITY

East China Mineral Exploration and Development Bureau

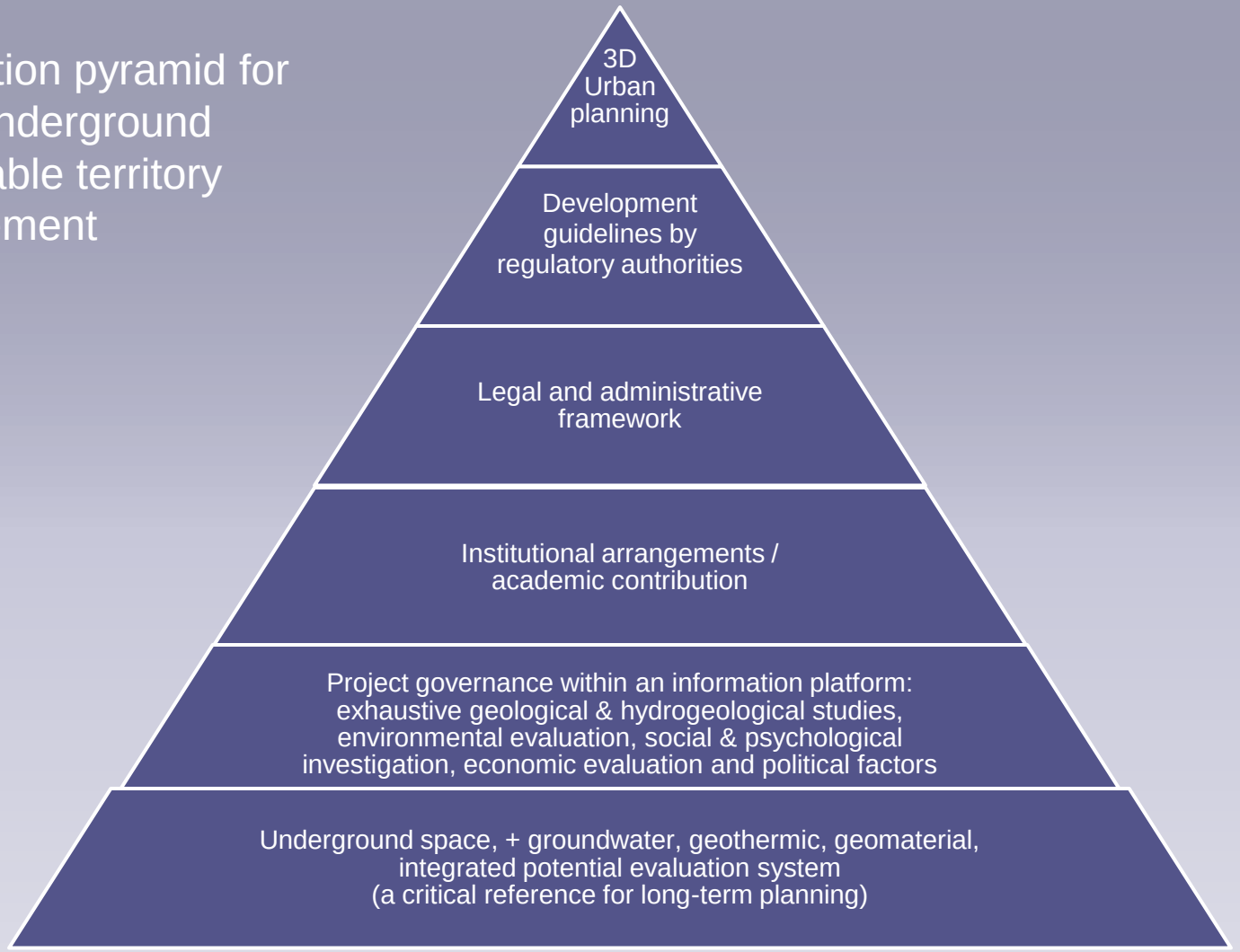
IUSG-Nanjing University

Complementary potential in urban underground management



Integrate a Deep City management system in China

Foundation pyramid for urban underground sustainable territory management



The foundation of the underground management pyramid is a global potential evaluation system of the underground resources.

1. The motivation

•Define a **universal management methodology** for much larger cities outside Switzerland.

•China, a typical fast developing country with numerous underground use developments and a critical challenge to manage a huge increase of population in urban sustainable development .

•The context of Chinese megacities differs in :

1. geological conditions & hydrogeological settings, climatology
2. scale of the cities, major needs, velocity of development
3. technical and financial means
4. existing environmental impacts

•Contribution of larger and more complex parameters to research on a long-term underground space planning.

•A collaboration also leads to a reduction of accidents in tunneling operations due to insufficient knowledge of geological conditions.

2. Define a 3D urban land planning in Chinese megacities with DEEP CITY concept

Step 1 : Lessons of the past in Chinese underground space development

- Success & Failures
- Critical factors to improve the sustainability
- New mode of interactions between resources

Step 2: Test the applicability of Deep City methodology by a pilot project in Jiangsu Province*(provisional)*, Integrate a subsurface management system for urban sustainable development

-Database of geological & hydrogeological survey, existing underground structures on the location
-Valorize data representation to improve the quality of prevision
- Governance in the socio-economic and political background
- Global potential evaluation system of underground resources , Multi-use integrated planning
-Change the management process in city planning to a new approach "From the resources to the need"

Step 3: Create a general management methodology for urban underground space development, contribute to the urban space planning worldwide

-Identification of the resources (space, groundwater, geothermic, geomaterial)
-Long-term planning based on global potential evaluation and sustainability quantification
-Exploitation of underground space according to the resource life-cycle

3. Background of underground development in Jiangsu Province

•A strong coastal city network near Yangtse River

Potentials:

1.The particular highest economic development, the largest scale of urban underground space exploitation in China.

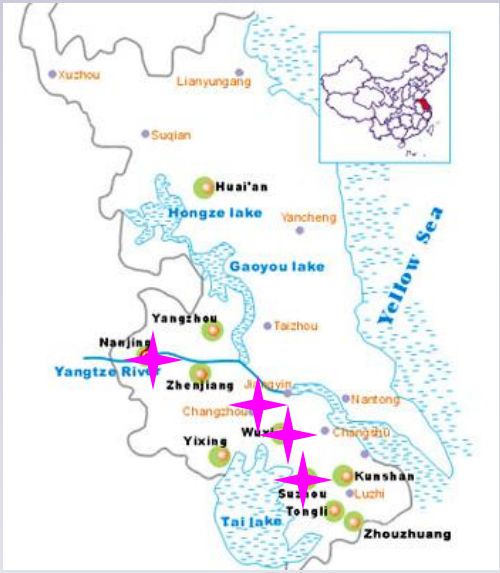
2.Similar natural geographical situation, with different geo-engineering conditions.

Constraints:

severe engineering accidents, land subsidence, earth fissures, groundwater pollution.

WHY?

- Insufficient knowledge of geological and hydrogeological conditions.
- Ignorance of the global potential of underground resources
- Lack of long-term planning for underground use
- Lack of collaboration between different stakeholders in urban planning
- An urgency to research on the underground space-resources integrated planning



DEEP CITY Scenario 1

The parameters in social-economic-legal governance:

Public need and expectation:

- security, easy access,
- green open space on the surface, comfortable indoor architectural design for buried area,
- housing density in the province and demand for high quality of life enables more utility facilities, parking and leisure centers to go underground.

Economic aspects:

- opportunity of economic-stimulus measures by Chinese government,
- long term profit and saving can be analyzed by quantifying the direct and indirect advantages from underground use.

The right of ownership and use:

- "State owns both the underground and all resources",
- the right of use belongs to different private parties.

Sustainable Policy and Environmental Protection Law:

•groundwater and aquifer system protection,

•disposal of excavated material, surface environmental impacts control

•Protection of the urban heritage to preserve a precious Chinese culture and history in the province.

•Sustainable development strategies in a developing country.

Education & Training:

•provide necessary education of underground use to decision-makers for planning issues,

•enhance public awareness of "underground is part of the city" in order to increase acceptability.

DEEP CITY Scenario 2

Underground resources exploitation at the coastal cities in Jiangsu Province:

Subsurface Space:

•A centralized area for underground space development

•main use: metro, cross-river tunnel, public utility tunnel, commercial center, civil air defense

•Significant engineering accidents due to insufficient geological knowledge

Groundwater:

•Abundant rainfall and surface water bodies for recharge, exploitation over 90 years.

•Lack of planning for industrial use and drinking use based on its quality and quantity

•Severe land subsidence due to overpumping, threatening the underground structures..

Geothermal energy:

•Shallow thermal energy to develop in Nanjing and Suzhou

•Lack of planning to serve construction

Geomaterials:

•Abundant construction material resources.

•Lack of planning of valorization and reutilization for construction.

•Mechanism and mode of interactions between exploitation of different resources under different conditions and scales.

•Global exploitation potential based on the spatial and temporal distribution for long-term use and sustainable development.

•Coordination of the different structures based on the geo-environment system.

DEEP CITY Scenario 3

To integrate a sustainable underground management system into the city planning…

CONCLUSION:

✓Underground space is limited, its exploitation may interfere with other resources like groundwater, material and geothermic.

✓Synergies between them (such as metro with geostructure, etc) have to been encouraged by the local urban development bodies and national resources management department.

✓Before going underground, a flexible legal and institutional framework have to be established so as to guarantee the success of underground space development.

✓City planning process should integrate a third dimension - underground space planning, development guidelines have to be established by the regulatory authorities to assist their development, feasibility studies and implementation.

✓The world development of underground space planning and management, shares an international interest, enables a complementary collaboration, contributes to an advanced research, directs to a sustainable world and a harmonious future.

Thank you