# FIG Working Week 2012
## Rome, Italy 6–10 May

Knowing to: Manage the territory
Protect the environment
Evaluate the cultural heritage

## HUMANS AND ENVIRONMENT: CAUSE AND EFFECT ANALYSIS SUPPORTED BY SPATIAL DATA INFRASTRUCTURES

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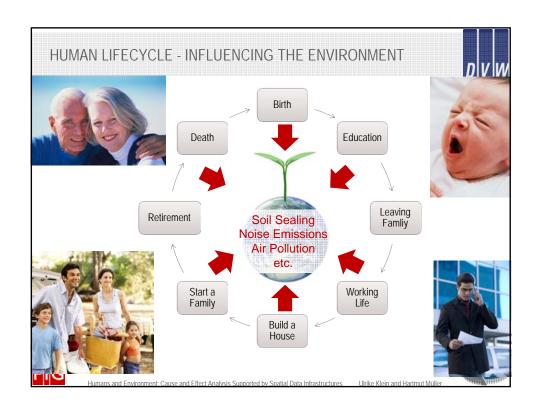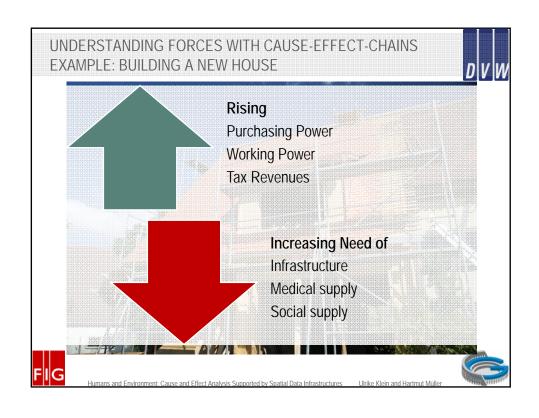[2]FH Mainz University of Applied Sciences, Mainz, Germany

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DVW

## INTERACTIONS BETWEEN HUMANS AND ENVIRONMENT

CURRENT CHALLENGES

Land Use Concurrences?

Environmental Degradation?

Social Problems?

dailygalaxy.com

Sustainable decisions require a holistic view!

HUMAN LIFECYCLE - INFLUENCING THE ENVIRONMENT

Birth

Death

Education

Retirement

Soil Sealing
Noise Emissions
Air Pollution
etc.

Leaving Famliy

Start a Family

Working Life

Build a House

UNDERSTANDING FORCES WITH CAUSE-EFFECT-CHAINS
EXAMPLE: BUILDING A NEW HOUSE

**Rising**
Purchasing Power
Working Power
Tax Revenues

**Increasing Need of**
Infrastructure
Medical supply
Social supply

REDUCING COMPLEXITY TO SYSTEMRELATED FACTORS AND
INDICATORS - A FIRST MODEL

Environmental System
Human System

climate
flora and fauna
surface
resources
waterbodies

pollution
biodiversity
recreation
soil sealing
food production
energy

infrastructure
construction and housing
business

stable infrastructure
population growth
technological progress
commodity flow

Education and culture
social care
health care
safety

personal qualities
research
solidarity
equal rights
prosperity
literacy rate
life expectancy
crime rate

SPATIAL INFORMATION MANAGEMENT TO SUPPORT THE
SUSTAINABLE PLANNING PROCESS

## SPATIAL DATA INFRASTRUCTURES IN EUROPE – EXAMPLE: GERMANY

**SDI - Europe (INSPIRE)**

**SDI - Germany**

GDI-DE

**SDI of the 16 federal states**

GDI-RP*   GDI-SH

**Local SDI**

Deutscher Städtetag   DEUTSCHER LANDKREISTAG   DStGB

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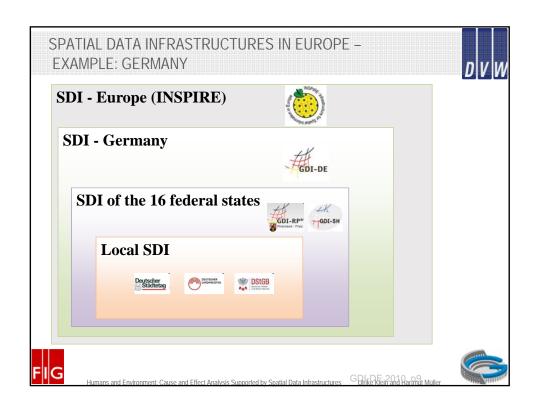
GDI-DE 2010  p9

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## INSPIRE  - INFORMATION POOL FOR SPATIAL PLANNING

- **Annex I:**  Coordinate reference systems, Geographical grid systems, Geographical names, Administrative units, Addresses, Cadastral parcels, Transport networks, Hydrography, Protected sites
- **Annex II:** Elevation, Land cover, Orthoimagery, Geology
- **Annex III:** Statistical units, Buildings, Soil, Land use, Human health and safety, Utility and governmental services, Environmental monitoring Facilities, Production and industrial facilities, Agricultural and aquaculture facilities, Population distribution and demography, Area management/ restriction/ regulation zones & reporting units, Natural risk zones, Atmospheric conditions, Meteorological geographical features, Oceanographic geographical features, Sea regions, Bio-geographical regions, Habitats and biotopes, Species distribution, Energy Resources, Mineral  Resources.

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## SERVICES FOR STANDARDIZED ACCESS

**Web Mapping Service (WMS)**
- Interface for processing requests of georeferenced map images
- Format: JPEG, PNG etc.
- Can be displayed in a standard web browser

**OGC®**
Making location count.
www.opengeospatial.org

**Web Feature Service (WFS)**
- Interface for data access
- Format: XML/GML
- Data elements can be created, deleted, updated, locked and queried

**Web Processing Service (WPS)**
- Enable additional processing of spatial information
- High-end geometrical, topological, thematic and temporal analysis of data

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**CASE STUDY: USE CASE BUILDING A NEW HOUSE**
**I. ANALYSING AND MODELLING SPATIAL RELATIONSHIPS**
**FOR SUSTAINABLE PLANNING**

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## PART 1: ASPECTS OF SUSTAINABILITY –
## INDICATORS AND CRITERIA FOR SUSTAINABLE PLANNING

| Ecological Indicators | | |
|---|---|---|
| Waste | Soil | Energy and resources |
| Land use | Noise | Settlement development |
| Air | Nature conservation | Natural scenery and landscape |
| Water | | |
| **Economical Indicators** | | |
| Employment | Education | Supply of services |
| Agriculture and forestry | Accessibility | Regional products |
| Economic structures | Economic development | Public budget |
| **Social Indicators** | | |
| Population development | Civic and democratic engagement; | Individual mobility and public transport |
| Recreation | Family and child care | Health |
| Socially responsible business | Inter-municipal cooperation | Distribution of income |
| Culture, cultural heritage | Participation | Seniors |
| Safety | Daily Supply | Distribution of work |
| Living space | | Equal rights |

Heiland et al. 2003, p. 203

## PART 1: ASPECTS OF SUSTAINABILITY – INDICATORS AND CRITERIA FOR SUSTAINABLE PLANNING

**Ecological criteria:**
- Reduction of primary energy consumption and increasing use of renewable energy
- Improvement of water quality
- Promotion of biodiversity, enhancement and maintenance of protected areas
- Improvement of soil quality and conservation of sensitive soils
- Improvement of air quality
- Avoidance of urban sprawl

**Socially criteria:**
- Creating good housing and living conditions and strengthening less-favoured areas
- Evaluate and manage the cultural heritage
- Improve mobility

**Economically criteria:**
- Improving the business environment and promoting jobs
- Strengthening the financial capacity of the municipality.

Behrendt 2010, p. 114

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## PART 2: HUMAN NEEDS (MASLOWS HIERACHY)



Maslows hierarchy of needs. Source: Wikipedia

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# PART 3: THE PLANNING RULES



Example of a legally binding land use plan of the study area

# PART 4: THE BUILDING PERMIT: SPATIAL RELATIONS BETWEEN HUMANS, ENVIRONMENT AND THE NEW BUILDING

| Site development with | Distance to | Position in/on | Proximity to |
|---|---|---|---|
| Street infrastructure | Railway | Protected sites | Natural monument |
| Waste water disposal | Forest and heath | Flood endangered area | Cultural monument |
| Rain water disposal | Water body | Land protection dyke | Open wire transmission line |
| Energy | Industrial mass production of livestock | Noise protection area of an airport | Dumpsite |
| Drinking water | Other emitting livestock | Areas of influence of contaminated sites | |
| Water for fire fighting purposes | Emitting industry | Areas contaminated with weapons | |
| | | Areas where the soil tends to settlements | |

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## RESULT I:
## CAUSE-EFFECT CHAIN FOR BUILDING A NEW HOUSE

**Causes:**
**New house**: new citizens, new cars, new tax revenues, new purchase power, new working power

**Affecting an increasing need of:**
**Ecologically:** soil, energy, water, resources, land use, solid waste disposal, waste water disposal, rain water disposal
**Economically:** employment, education, supply of services, agriculture and forestry, foods and goods, government, industry, transport network, regional products
**Socially:** recreation, entertainment, child care, health care

**Causing impact on:**
**Ecologically:** air quality, water quality, soil quality, use of resources, use of land, occurrence of species, biodiversity, protection of natural resources, landscape, nature conservation, settlement development, volume of waste
**Economically:** accessibility, use of supply, public budget, settlement development, economic structure, economic development
**Socially:** population development, distribution of income, participation, distribution of work, healthy living and working conditions, safety, culture protection, individual mobility

**Affecting:**
**Ecologically:** soil sealing, air pollution, water pollution, emissions, resource consumption, energy consumption, contamination, number of species, noise
**Economically:** financial capacity of the municipality, attractiveness for business and industry
**Socially:** physiological needs, safety, social needs, individual needs, self-realisation

**Sustainability Responses:**
**Ecologically:** reduction of primary energy consumption, increasing renewable energies, improve water quality, promotion of biodiversity, enhancement of protected areas, improve soil quality, improve air quality, avoidance of urban sprawl
**Economically:** improving the business environment and promotion of jobs, strengthen the financial capacity of the municipality
**Socially:** creating good housing and living conditions, strengthening less-favoured areas, evaluate and manage the cultural heritage, improve mobility

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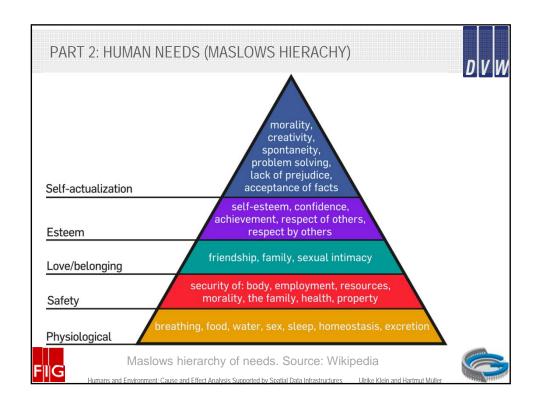## CASE STUDY: USE CASE BUILDING A NEW HOUSE
## II. SUPPORT FOR CAUSE AND EFFECT ANALYSIS BY
## SPATIAL DATA INFRASTRUCTURES

Adresses
Parcels
Administrative units
Geographical names
Transport networks
Hydrography
Protected sites

INSPIRE Annex I data for the planning area, loaded as WMS-services, accessible through the internet, no costs.
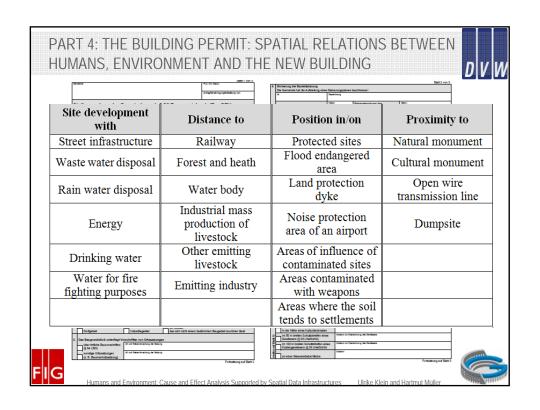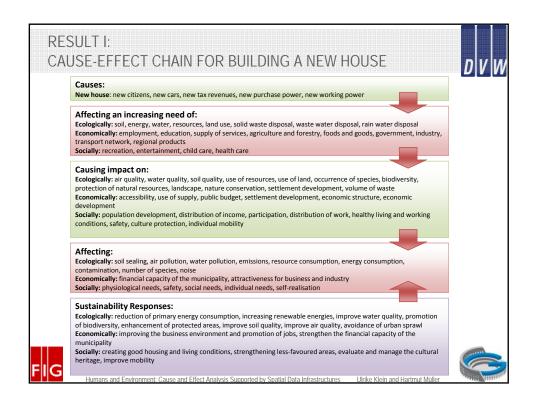
Data source: Schleswig-Holsteins State Surveying Authority.
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## DIMENSION 2: EXAMINATION OF PLANNING ASPECTS

- *Task*: Considering ecological, economical and social aspects
- *Solution:* Most parts of required spatial information will be available after full implementation of INSPIRE-Directive.

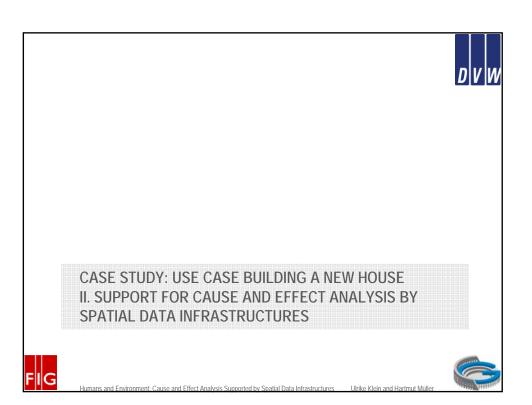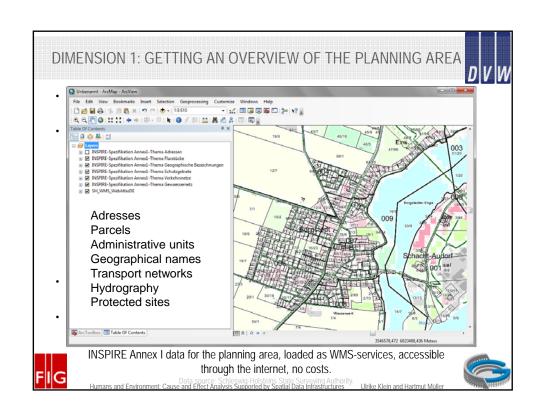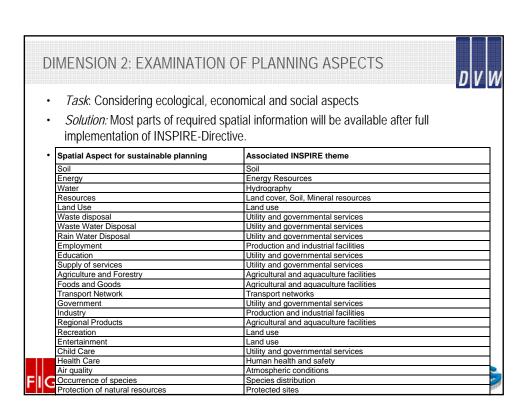| Spatial Aspect for sustainable planning | Associated INSPIRE theme |
|---|---|
| Soil | Soil |
| Energy | Energy Resources |
| Water | Hydrography |
| Resources | Land cover, Soil, Mineral resources |
| Land Use | Land use |
| Waste disposal | Utility and governmental services |
| Waste Water Disposal | Utility and governmental services |
| Rain Water Disposal | Utility and governmental services |
| Employment | Production and industrial facilities |
| Education | Utility and governmental services |
| Supply of services | Utility and governmental services |
| Agriculture and Forestry | Agricultural and aquaculture facilities |
| Foods and Goods | Agricultural and aquaculture facilities |
| Transport Network | Transport networks |
| Government | Utility and governmental services |
| Industry | Production and industrial facilities |
| Regional Products | Agricultural and aquaculture facilities |
| Recreation | Land use |
| Entertainment | Land use |
| Child Care | Utility and governmental services |
| Health Care | Human health and safety |
| Air quality | Atmospheric conditions |
| Occurrence of species | Species distribution |
| Protection of natural resources | Protected sites |

## DIMENSION 3: ANALYSIS OF SPATIAL CONNECTIONS

- *Task:* Identifying spatial connections concerning the planning area
- *Solution:* Using spatial tools like buffers or point-in-polygon-analysis to analyze spatial relationships between causes and effects
- *Precondition:* Spatial Data is availiable in WebFeatureServices (WFS)



Spatial analysis for spatial relationships. Example: potential emissions.

## DIMENSION 4: MEASURING THE IMPACT

- *Task:* Summarizing spatial effects to a holistic impact factor
- *Solution:* Using WebProcessingServices to orchestrate WFS-Services and to create complex applications to automate requests on impact factors
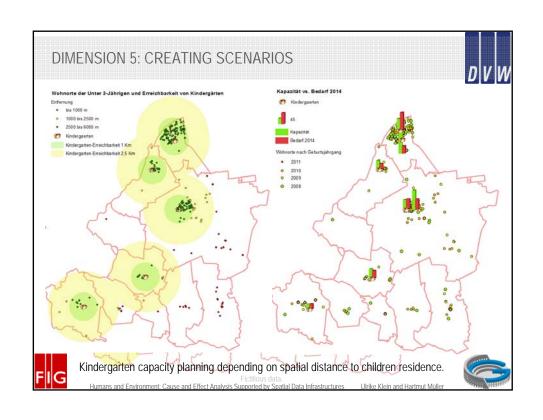- *Preconditions:* Availability of WFS-Services, GIS-Professionals to define the process



Automatically generated environmental impact of house building.

# DIMENSION 5: CREATING SCENARIOS



Kindergarten capacity planning depending on spatial distance to children residence.
Fictitious data.

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# DESIGNING A DIGITAL WORLD FOR SUSTAINABLE PLANNING – RESULTS AND CONCLUSION

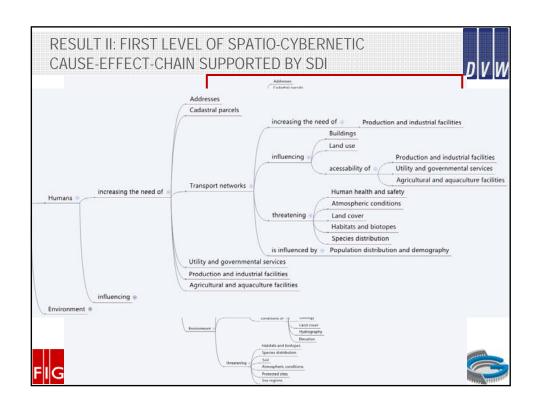Humans and Environment: Cause and Effect Analysis Supported by Spatial Data Infrastructures     Ulrike Klein and Hartmut Müller

## REMEMBER RESULT I:
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## RESULT II: FIRST LEVEL OF SPATIO-CYBERNETIC
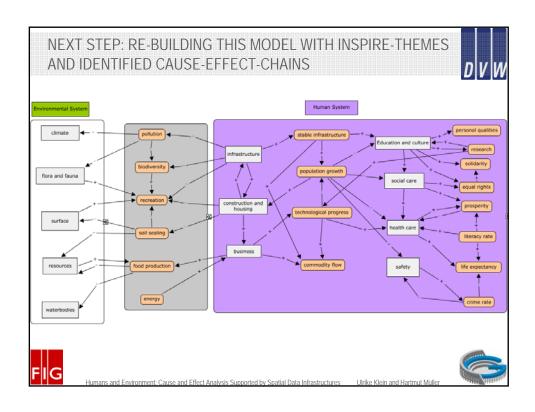## CAUSE-EFFECT-CHAIN SUPPORTED BY SDI

## CONCLUSIONS

- Humans and environment interact in many different ways ⇨ Changes of land use always causes environmental, social, urban and economic impacts.

- Aspects of sustainability have to be taken into account and guide each planning process.

- Cybernetic control instruments like Vesters (2007) „model of sensivity" can be used to downscale complex systems to a managable level

- Models and their indicators can be transferred to a spatial context using spatial informatics.

- Spatial Data Infrastructures can provide necessary information.

- Spatial Data Infrastructures can support spatio-cybernetic cause and effect analysis

- **Spatial Information Systems and Spatial Data Infrastructures facilitate a holistic, sustainable, spatio-cybernetic planning-process**

THANK YOU FOR LISTENING

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