GIS represents, in my opinion, the single biggest contribution geographers have made since the age of discovery.” (Patrick Wiegand, 2001)

“Everything is related to everything else, but near things are more related than distant things.” (Waldo Tobler, 1970)

“A map is the greatest of all epic poems. Its lines and colors show the realization of great dreams.” (Gilbert H. Grosvenor 1875–1966)

“Knowing where things are, and why, is essential to rational decision making.” (Jack Dangermond, 2001)

Semester 4

Module Coordinator Pascal Ochsner

Lecturers Nick Bell
Martin Geilhausen
Martina Hediger
Patrick Laube
Pascal Ochsner

Latest update February 2015
M - 1. OVERVIEW OF THE MODULE

M - 1.1 FORMAL DESCRIPTION
Code n.BA.UI.GIS4S
Module Geographic Information Systems (GIS)
Type Elective module
ECTS-Credits 4
Semester 4

M - 1.2 ABSTRACT
Geographic Information Systems provide opportunities to capture, manage, analyse and present spatial data. In today’s information society, they are used with increasing frequency in both the private sector and public administration.

The theoretical principles of Geographic Information Systems, the essential skills needed to work with them, and their capabilities are examined in this module. Through lectures, practical exercises, project-based education and blended-learning, students gain the necessary skills to utilize Geographic Information Systems purposefully in their future working environments.

M - 1.3 GENERAL AIMS
After completing the module, students are capable of building data models, performing vector- and raster-based data analysis, and creating maps using a GIS. Furthermore, they are able to plan GIS projects from the start, giving consideration to all aspects that contribute to a successful project.

M - 1.4 ASSESSMENT
The grade awarded is based on a one-hour written theoretical exam and a two-hour written practical exam. In addition, at least two written practical reports must be submitted and an oral presentation given.

M - 1.5 STRUCTURE OF THE MODULE

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<thead>
<tr>
<th>Semester week</th>
<th>1</th>
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<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
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</thead>
<tbody>
<tr>
<td>Classroom teaching</td>
<td>Data presentation</td>
<td>Data management and modelling</td>
<td>Data collection</td>
<td>Data analysis (vector)</td>
<td>Data analysis (raster)</td>
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<td>Assignments</td>
<td>A1</td>
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<td>Exams</td>
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<tr>
<td>Workload</td>
<td>The module consists of 4 lessons (classroom teaching) per week. An additional workload of approximately 4 hours per week is required for essential self-study.</td>
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**M - 1.6 ENTRY REQUIREMENTS**

To participate in the Geographic Information Systems (GIS) module, the following basic knowledge is required:

- Students should have good PC operating system and Microsoft Office (especially Excel and Access) skills.
- Students must be able to copy, move, compress and delete data files as well as develop a useful and ordered data structure.
- Students should be familiar with the most common text (*.docx, *.pdf), table (*.xlsx), database (*.accdb) and image (*.jpg, *.png, *.tif, *.bmp) formats.
- Students should have basic knowledge of semantic data modelling and be familiar with the database terms “relation” and “cardinality”.

The following additional knowledge is also required:

- Students need to be familiar with the Swiss Coordinate System. They should be able to find a location on the Swiss National Map on the basis of coordinates provided and be able to define the map coordinates for any point.
- Students must be able to read maps and should be familiar with the most important map symbols on the Swiss National Map. Furthermore, they should understand the terms “north arrow”, “map scale” and “legend”.

**M - 1.7 MODULE EVALUATION**

The module is evaluated using an anonymous questionnaire at the end. This evaluation is used to assess the general module content and the achievements of the lecturers. The feedback is analysed and the results are communicated to the students and discussed by the lecturer team. Findings based on this evaluation are taken into account when planning the next module.
M - 2. LEARNING OBJECTIVES

M - 2.1 COMPETENCES AND LEARNING OUTCOMES

Professional and methodological competence
Students understand the structure of a GIS, are familiar with the most common geodata formats, and are able to independently capture, manage, analyse and present spatial data.
They are able to create geometric and topologically precise databases, modify them, and make them transferable within projects.
They understand the structure of a geodatabase and are able to model, create and edit geodatabases.
They are able to create maps and presentations, and assess them in regard to their communicative effectiveness.
They are familiar with the most important vector- and raster-based selection and geoprocessing tools, and are able to use them to analyse existing databases and derive new information in a goal-oriented manner.
They understand the functional principles of Global Navigation Satellite Systems (GNSS).
They are able to plan a GIS project in a goal-orientated way from start to finish, both on their own and in a team, and can efficiently execute, correctly document, and successfully complete such a project.
They understand the principle and characteristics of spatial referencing systems and are able to abstract and formalise spatial issues.
They are able to independently acquire specific skills and knowledge in the field of geoinformatics and give a presentation to an audience in English.

Social competence
Students can help each other to solve problems and achieve greater understanding of an issue or topic by publishing their questions in a discussion forum on the Moodle virtual e-learning platform.

Self-competence
Sophisticated tasks challenge students to be creative and to develop important problem-solving skills.
They are able to work in a problem-orientated manner, search for solutions, filter out the relevant information and complete a task independently or in a team.
M - 3. MODULE CONTENT

M - 3.1 THEMATIC INTRODUCTION TO THE MODULE
Geographic Information Systems have become well established in the private sector, in public administration and in science over the last decade. In our modern information society, GIS are widely used for solving problems or questions with a spatial aspect. Questions such as "What kind of spatial connections exist between objects?" can be efficiently answered using GIS.

Many decisions in daily life are related to spatial issues and as a result GIS are widely employed in many fields. GIS are the only way to capture, manage, analyse and present geometric data and attribute data taking into account their complex, logical and spatial relationships. Numerous spatial geoprocessing and analysis tools provide opportunities to gather new information, which can be used as a basis for decision-making processes. It is no longer possible to imagine working without GIS, especially in the field of environmental sciences with its interdisciplinary and geospatial issues. GIS are widely used in the assessment of natural hazards, spatial and transportation planning, environmental monitoring, wildlife management and for tree and biotope cadastres. Future GIS operators need fundamental and goal-orientated training in how to efficiently use these system capabilities in professional practice.

M - 3.2 KEY CONTENT

Introduction and data presentation

Key questions
- What components need to be considered so that a GIS can be successfully used in a developing country?
- In which application fields are GIS broadly used?
- What characterises a high quality map?

Key terms
- Components of a GIS; IMAP principle; GIS project
- ArcGIS; ArcMap; ArcCatalog; ArcToolbox; Quantum GIS
- Cartography; map layout; generalisation; coordinate system; geographic transformation, georeferencing

Data management and modelling

Key questions
- What are the characteristics of the storage of objects in a GIS in contrast to data storage in a common database (i.e. Access)?
- How can the real world be described with an abstract spatial data model?

Key terms
- Data formats and data types; attribute and geometry data; shapefile
- Topology
- Spatial, conceptual, logical and physical data model; geo-database
**Data collection**

*Key questions*
- Which data provider should be contacted if a specific geo-dataset is needed for a project?
- What different data collection methods are there, and what is the difference between them?
- What is the benefit of using satellite navigation systems during field data acquisition?

*Key terms*
- Spatial base data and thematic data; metadata; geodata providers; OpenSource; WMS and WFS services
- Primary and secondary acquisition methods
- GNSS and GPS

**Data analysis**

*Key questions*
- How can students answer questions such as...
  - ...where are potential deer habitats located in the Canton of Zurich?
  - ...how long does it take to drive from Zurich to Chur by car without using motorways?
  - ...how many GSM antennas are located within a specific distance of a given location?
  - ...which buildings in a municipality are vulnerable to floods?

*Key terms*
- SQL; thematic and topological selection; join
- Overlay and distance analysis
- Automation; ModeBuilder
- Local, focal, zonal and global functions
- MapAlgebra
M - 4. LEARNING WITHIN THE MODULE

M - 4.1 DIDACTIC PRINCIPLES

The Geographic Information Systems (GIS) module is orientated towards the following learning principles:

**Competence orientation:** During the module students develop knowledge that qualifies them to process and solve simple as well as relatively complex spatial-based problems using a GIS. The learning outcomes are based on a competency grid, which is given to students at the beginning of the module.

**Practice orientation:** The contents of the module are mainly orientated towards practical requirements. To support the learning process, practically relevant issues and current trends are studied. This is done through exercises, learning tasks and assignments. This practice orientation prepares students to successfully manage and handle future professional challenges.

**Action orientation:** The module is based on the concept of developing independence through personal action. A holistic understanding is achieved through the integration of thinking, actions and feelings in lessons.

**Graduated learning:** The aim is to gain sustainable knowledge through the use of repetition and by applying skills learnt to new issues, a process that demands active student collaboration.

M - 4.2 LEARNING ARRANGEMENTS

The module relies on a mixture of self-study and teacher-guided learning.

**Lectures:** Basic theoretical knowledge and main causal connections are studied in lectures, which develops students’ professional expertise. The lectures are also supplemented by input from external lecturers, allowing students to gain an invaluable practice-orientated insight into specific fields of application for geoinformatics.

**Lab (exercises):** The theoretical knowledge acquired in a previous lecture is applied in subsequent computer exercises, based on practical and specific tasks. Individual, partner and group work helps to develop methodological and personal skills. If required, lecturers introduce the task and are on hand to help and advise students.

**Self-study:** Students are also expected to extend their knowledge and understanding through self-study and repetition.

**Blended Learning:** The Moodle e-learning platform is used as a tool where students can access the course documents and further information. Additional self-study exercises are available for each course topic. The course instructors also use the Moodle platform as a message forum. A discussion forum, hosted by the lecturers, provides an opportunity for students to exchange views on subject-specific and methodical questions. Furthermore, students have the opportunity to use other e-learning platforms (e.g. GITTA Geographic Information Technology Training Alliance or FerGI Fernstudienmaterialien Geoinformatik) where many more learning modules are available to them. The lecturers refer to other recommended learning resources during the module.

**Integrated English:** All communication, both written and oral, is in English, including the course materials. All written practical reports, the final oral presentation, and the theoretical and practical exams are also in English. In addition to basic geoinformatics skills, students have the opportunity to extend their English language skills and become acquainted with English technical terminology.
M - 4.3 COURSE MATERIALS

The course materials (lectures and lab) are provided in written form. Students are also required to make additional notes. Extended course materials are available for download on the Moodle e-learning platform. The exams are based on the course materials.

M - 5. SET BOOKS, RECOMMENDED AND FURTHER READING

Although there is no required reading, the following texts are recommended:
M - 6. ASSESSMENT

M - 6.1 RECORD OF ACHIEVEMENT

<table>
<thead>
<tr>
<th>Form of Assessment</th>
<th>Evaluation / Weighting for module mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignments</td>
<td>2 practical reports</td>
</tr>
<tr>
<td>Presentation</td>
<td>English presentation at the end of module</td>
</tr>
<tr>
<td>Theory</td>
<td>Written exam (semester week 10)</td>
</tr>
<tr>
<td>Practical</td>
<td>Written exam on school computer</td>
</tr>
</tbody>
</table>

**Practical reports**: Students are given assignments to complete in semester weeks 2, 4 and 8. They have to submit at least two written practical reports based on the tasks in these assignments. Students have a free choice as to which assignments they submit the required reports for. The requirements for these practical reports are published in advance. Provided students submit two reports that correspond to the assignment requirements by the due date, they have fulfilled this part of the module. These practical reports are not graded.

**Presentation**: Students are expected to give a presentation in English during the plenary sessions in semester weeks 13 and 14. Attendance is mandatory during the presentation sessions. Feedback is provided for the presentation but a grade is not included in the final grade for the module.

**Theory exam**: Instead of a lecture in semester week 10, there is a one-hour theory exam. The mark for this exam counts as one third of the module mark. No tools and aids are allowed during this exam.

**Module exam**: The written two-hour module exam is held in the computer labs. Students can either work on their own notebooks or on the school computers. Course materials, personal notes, practical reports and the internet may all be used as sources of information. Practical skills, in particular, are tested in this exam. The grade from this exam counts as two thirds of the module mark. A minimum grade of 4 is required to pass the module. A grade of 4 is given when the minimum level of competency defined by the course lecturers is achieved.

M - 6.2 GENERAL CONDITIONS

Students are required to submit two practical reports, based on the tasks given in the assignments, by the due date. There is also an additional presentation in English. These three assignments are not graded. However, if a student does not complete these three assignments, they receive a grade of 1 for theory exam. Further information can be found in the ZHAW’s current examination regulations.
<table>
<thead>
<tr>
<th>Semester week</th>
<th>Type of event</th>
<th>Content of the lessons</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2h lecture</td>
<td><strong>Introduction</strong>: general module information, Geographic Information System, GIS project</td>
</tr>
<tr>
<td></td>
<td>2h lab</td>
<td>Introduction to the software (ArcGIS), layer principle</td>
</tr>
<tr>
<td>2</td>
<td>2h lecture</td>
<td><strong>Data presentation</strong>: fundamentals of cartography, coordinate systems and map projections, coordinate transformation, georeferencing</td>
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<tr>
<td></td>
<td>2h lab</td>
<td>Coordinate transformation and presenting of spatial data</td>
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<tr>
<td>3</td>
<td>2h lecture</td>
<td><strong>Data management and modelling I</strong>: Data formats and types, geometric and attribute data, entity and field model</td>
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<td></td>
<td>2h lab</td>
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<tr>
<td>4</td>
<td>2h lecture</td>
<td><strong>Data management and modelling II</strong>: Semantic data modelling; ERM; topology rules</td>
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<td></td>
<td>2h lab</td>
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<tr>
<td>5</td>
<td>2h lecture</td>
<td>Input on how to make presentations</td>
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<td></td>
<td>2h lab</td>
<td>Distribution of tasks (presentations), organisation of presentations</td>
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<tr>
<td>6</td>
<td>2h lecture</td>
<td><strong>Data acquisition</strong>: overview of data sources, importance of metadata, accuracy of spatial data</td>
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<tr>
<td></td>
<td>2h lab</td>
<td>Open Source data handling, quality of geodata, metadata, integration of wms-services</td>
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<tr>
<td>7</td>
<td>Contingency</td>
<td>Holidays (Easter, Ascension Day, Whitsun)</td>
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<tr>
<td>8</td>
<td>2h lecture</td>
<td><strong>Data analysis I</strong>: query language (SQL), thematic and topological selection</td>
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<td></td>
<td>2h lab</td>
<td>Queries and selections</td>
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<tr>
<td>9</td>
<td>2h lecture</td>
<td><strong>Data analysis II</strong>: methods of vector analysis, geoprocessing, automation</td>
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<tr>
<td></td>
<td>2h lab</td>
<td>Geoprocessing with ArcToolbox and ModelBuilder</td>
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<tr>
<td>10</td>
<td>1h exam</td>
<td><strong>Written exam (theory)</strong></td>
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<td></td>
<td>3h lab</td>
<td>Geoprocessing with ArcToolbox and ModelBuilder</td>
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<tr>
<td>11</td>
<td>2h lecture</td>
<td><strong>Data analysis III</strong>: methods of raster analysis</td>
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<td></td>
<td>2h lab</td>
<td>Working with raster data and raster data analysis</td>
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<tr>
<td>12</td>
<td>4h lab</td>
<td>Case study &quot;habitat modelling&quot;</td>
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<tr>
<td>13</td>
<td>2h presentations</td>
<td><strong>Presentation in English (group A)</strong></td>
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<td></td>
<td>2h lab</td>
<td>Case study &quot;habitat modelling&quot;</td>
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<tr>
<td>14</td>
<td>2h presentations</td>
<td><strong>Presentation in English (group B)</strong></td>
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<tr>
<td></td>
<td>1h lecture</td>
<td><strong>Final lecture</strong>: evaluation of module, training opportunities</td>
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<tr>
<td></td>
<td>1h lab</td>
<td>Case study &quot;habitat modelling&quot;</td>
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</table>