# MODULE: Stochastical Modeling and Geostatistics

Last Update: 19.07.2011

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Details</th>
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<tbody>
<tr>
<td>1</td>
<td>Modulname/Module name</td>
<td>Stochastical Modeling and Geostatistics</td>
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<tr>
<td>2</td>
<td>Modulkürzel: Identification code</td>
<td>021430003</td>
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<td>3</td>
<td>Leistungspunkte (LP)/Credit points (CP)</td>
<td>6</td>
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<td>4</td>
<td>Semesterwochenstunden (SWS)/Semester load</td>
<td>4</td>
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<td>5</td>
<td>Moduldauer (Anzahl der Semester)/Module duration (Number of semesters)</td>
<td>1 Semester</td>
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<td>6</td>
<td>Turnus/Cycle</td>
<td>every 2nd semester</td>
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<td>7</td>
<td>Sprache/Language</td>
<td>German or English depending on the participants</td>
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<td>8</td>
<td>Person in charge of module/Modulverantwortliche(r)</td>
<td>Prof. Dr. rer. nat. Dr.-Ing. habil. András Bárdossy</td>
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<td></td>
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<td>Institut für Wasserbau</td>
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<td>Email: <a href="mailto:Andras.Bardossy@iws.uni-stuttgart.de">Andras.Bardossy@iws.uni-stuttgart.de</a></td>
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<tr>
<td>9</td>
<td>Lecturers</td>
<td>Prof. Dr. rer. nat. Dr.-Ing. habil. András Bárdossy (Vorlesung) N.N. (Übung)</td>
</tr>
<tr>
<td>10</td>
<td>Verwendbarkeit/Zuordnung zum Curriculum/Applicability/Assignment to curriculum</td>
<td>UMW (M.Sc.), K, SS; BAU (M.Sc.), K, SS WAREM (M.Sc.), K, Mandatory for Section, 2nd Semester, (SS)</td>
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<td>11</td>
<td>Prerequisites</td>
<td>Recommended background knowledge:</td>
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<td>Basic knowledge of statistics</td>
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<td>Prerequisite module: none</td>
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<td>12</td>
<td>Lernziele/Intended learning outcome</td>
<td><strong>Concepts of Geostatistics:</strong> Knowledge of the basic geostatistical concepts, difference between Kriging and simulation, advantages and disadvantages of the discussed methods, application of Kriging and simulation</td>
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<td><strong>Stochastical Modeling:</strong> The participants have skills in basic statistical methods used in hydrology, like time series analysis, extreme value statistics, parameter estimation methods and statistical tests.</td>
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**Concepts of Geostatistics:**
Geostatistical procedures for the interpolation of measured values, assessment of model parameters and planning of measuring networks are dealt with.

**Contents:**
- Introduction
- **Statistical hypotheses:**
  - Basic concepts; Regionalized variables; Second order stationarity; Intrinsic hypothesis; Comparison of the two hypotheses; Selection of the regionalized variable
- The variogram: The experimental variogram; The theoretical variogram; Variogram models; Variogram fitting; Isotropy — anisotropy
- Ordinary Kriging: Point kriging; Block kriging; Properties of ordinary kr.; Kr. as an interpolator; Kr. and the variogram; Practice of kr.; Selection of the neighbourhood; Kr. with a “false” variogram; Cross validation; Kr. with uncertain data; Simple Kr.
- Non stationary methods: Universal kr.; Intrinsic random functions of order k; External-Drift-Kr.
- Indicator Kriging: Indicator Kriging; Applications
- Kriging with arbitrary additional information: Markov-Bayes-Kriging; Simple Updating (SU)
- Time dependent variables
- Simulations:
  - Basic definitions; Monte Carlo; Turning Band; Unconditional simulation; Conditional simulation; Sequential Simulation; Simulation using Markov Chains; The Hastings Algorithm; Simulated annealing; Indicator Simulation; Truncated-Gaussian Simulation; Application of simulations
- Exercises

**Stochastical Modeling:**
The lecture part stochastic modeling is primarily concerned with the stochastic analysis of temporal and areal arrays, their generation and their use in the hydrological modeling. Calculation and analysis of hydrological data, descriptive statistic and their parameters, possibility analysis, correlation and regression, time series analysis and simulation.

**Content:**
- Univariate Statistics and multivariate Statistics (e.g. regression analysis)
- Theory of probabilities
- Random variables and probability functions (e.g. Poisson distribution)
- Estimation of parameters (e.g. Maximum Likelihood Method)
- Statistical tests (e.g. Kolmogorov-Smirnov test)
- Extreme value statistics (analysis of the frequency of occurrence of floods)
- Time series analysis (e.g., ARMA Models)
- Stochastic simulations (Monte-Carlo Methods)
| 14 | Literatur/Lernmaterialien | Geostatistics:  
Introduction to Geostatistics (Lecture notes, English)  
Kitanidis, P. K (1997): Introduction to geostatistics: applications to hydrogeology  
Armstrong, Margaret (1998): Basic linear geostatistics  
Stochastical Modeling:  
| 15 | Lehrveranstaltungen und Lehrformen  
Course units and teaching methods | Concepts of Geostatistics, lecture, 2 SWS, 3 LP  
Stochastical Modeling, lecture and exercise, 2 SWS, 3 LP |
| 16 | Abschätzung des Arbeitsaufwands  
Estimation of workload | |
| 17a | Studienleistungen (unbenotet)  
Course achievements (without mark) | None |
| 17b | Studienleistungen (benotet)  
Course achievements (with mark) | None |
| 18 | Grundlage für…  
Basis for… | |
| 19 | Medienform  
Media | |