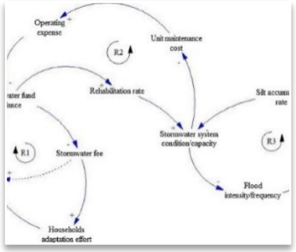
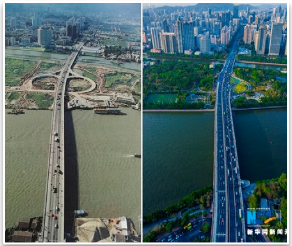
Topics

Master project and thesis

Master thesis

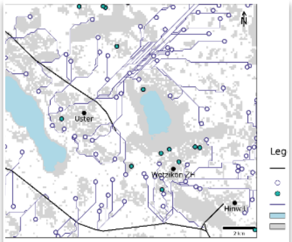


1. System dynamics model to determine funding allocation

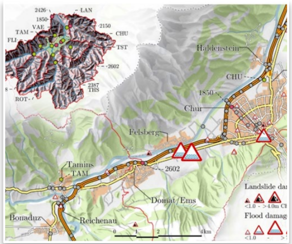


2. Land-Use transport interaction modelling for infrastructure planning

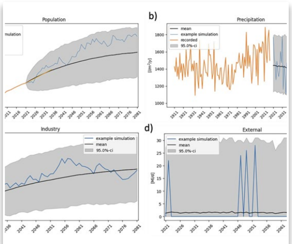
3. Quantifying the benefits of car-lite interventions



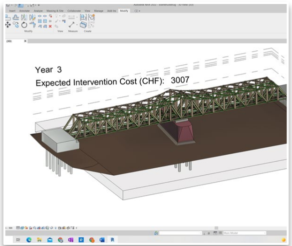
4. Predicting railway development using geospatial tools



5. A real time transport system digital twin to minimize risk



6. Using a digital twin to facilitate planning water system development



7. Connecting future predictions of asset condition and interventions to BIM

8. Estimating missing risk data with Bayesian networks

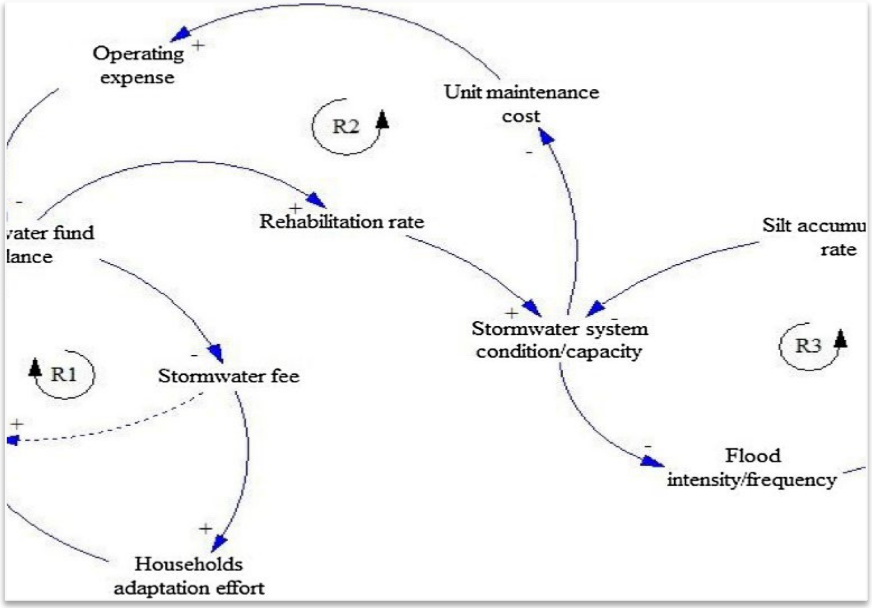
9. Use of extended reality for bridge inspections

10. Asset management approaches to enable resilience

1 – System dynamics model to determine funding allocation

Limited to 1

- **Supervisors:** D. Zani (zani@ibi.baug.ethz.ch), Prof. Dr. B.T. Adey
- **Goal:** To replicate and further develop a model of how a nationwide infrastructure system works to enable the setting of high-level goals considering constraints.
- **Main Tasks:** 1) critically evaluate the key variables to be included in the model, 2) critically evaluate the relationships used in the model, 3) replicate the existing model in an environment in which you are comfortable, 4) test the model for plausibility using sensitivity analysis, 5) discuss the strengths and weaknesses of the model and propose potential improvements.
- **What you will learn:** how to model complex systems at a high-level, the strengths and weakness of such models.
- **What is a successful project?** Reproduction of the model, competent explanation of the model, clear explanation of the strengths and weakness, and clear proposals for improvement.
- **Prerequisites:** Discussion with Prof. Adey. Experience / interest in modelling infrastructure system. Experience / interest in computer programming or knowledge of system dynamics software (e.g., Vensim).



Connected to Scottish Water

2 – Land Use Transport Interactions (LUTI) modelling for infrastructure planning

Limited to 2 persons

- **Supervisors:** O. Roman (oroman@ethz.ch) or J. Yap (jinyap@ethz.ch), Dr. Qiming Ye (qiming.ye@sec.ethz.ch), Prof. Dr. B.T. Adey
- **Goal:** To model the interactions between land use and transportation for a specific case study and use it to inform strategic long-term planning.
- **Main Tasks:** 1) Document / explain the evolution of a region (e.g., Zurich or Singapore) and its transportation infrastructure and land use policies for the previous decades, 2) gather the required datasets needed for the LUTI model (some will be provided), 3) develop/apply the LUTI model to the studied region (code will be provided), 4) calibrate and validate the model, 5) use the model to evaluate potential future infrastructure projects in the region (e.g. changes in travel time, accessibility, urban sprawl, densification).
- **What you will learn:** how to synthesize data collected from different sources, calibration and validation of LUTI models, and how to use models for infrastructure planning.
- **What is a successful project?** Convincing arguments on the use of the model to evaluate infrastructure projects. Identification of the limitations of the work and suggestions on how to use these tools in planning practice.
- **Prerequisites:** GIS and good knowledge/interest in programming with Python, discussion with Mr. Roman and/or Prof. Adey.

Connected to: (FCL) FUTURE CITIES LABORATORY

Institut für Bau- und Infrastrukturmanagement

D BAUG

Limited to 2 persons

3 – Quantifying the benefits of car-lite interventions

- **Supervisors:** O. Roman (roman@ibi.baug.ethz.ch) or J. Yap (jinyap@ethz.ch), Dr. Qiming Ye (qiming.ye@sec.ethz.ch), Prof. Dr. B.T. Adey
- **Goal:** To quantify/model the benefits (e.g. carbon emissions, accessibility, accidents, noise, travel time) of car-lite interventions (e.g., road space reallocation, mobility hubs, pedestrianization) for a specific case study in Zurich or Singapore.
- **Main Tasks:** 1) Review the literature on how the benefits of car-lite interventions are estimated, 2) select a case study (e.g. mobility hubs in Zurich) and gather the required data, 3) develop/expand models (code and existing tools will be provided) to estimate selected benefits, 4) calibrate and validate the model, 5) use the model to evaluate potential future car-lite interventions.
- **What you will learn:** how to synthesize data collected from different sources, quantification of benefits/modelling of car-lite interventions, and how to use models for infrastructure planning.
- **What is a successful project?** Convincing arguments on the use of the model/quantification methodology to evaluate projects. Identification of the limitations of the work and suggestions on how to use these tools in planning practice.
- **Prerequisites:** GIS and good knowledge/interest in programming with Python, discussion with Mr. Roman and/or Prof. Adey.

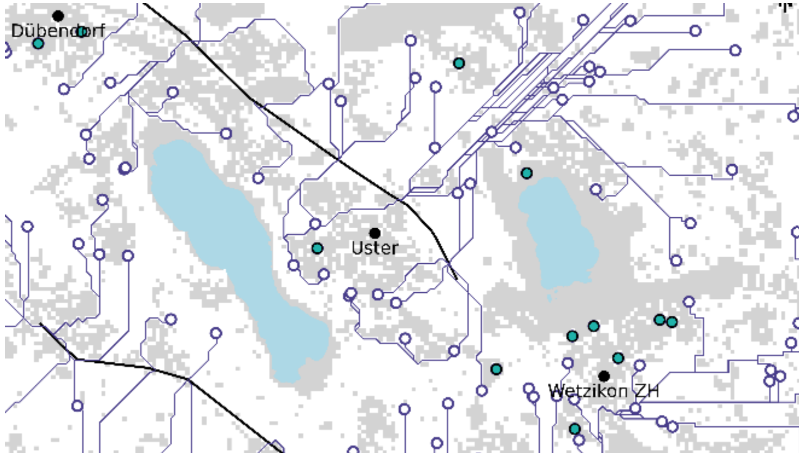
Connected to: (FCL) FUTURE CITIES LABORATORY

4 – Predicting railway development using geospatial tools

Limited to 1

- **Supervisors:** A. Elvarsson (elvarsson@ibi.baug.ethz.ch), Prof. Dr. B.T. Adey
- **Goals:** To generate potential evolution of a rail network considering various influencing factors, such as population growth, shifts in travel demand and land use policies. The study will utilize a case-study rail network and a state-of-the-art algorithm exploiting spatial analysis.
- **Main Tasks:** 1) Gather information for the rail infrastructure system, 2) identify the planning objectives, 3) summarise literature findings on the growth and evolution of transport networks, including recent developments at Chair of Infrastructure Management, 4) develop at least three distinct scenarios that impact rail networks in future, 5) use a novel algorithm to generate changes to the case study rail network, 6) assess the changes to the network considering the stakeholders affected, and 7) identify rail network modifications that can provide societal benefits
- **What you will learn:** Develop programming skills useful for decision-support models, quantitative planning support, how to build solid arguments for decision-makers in infrastructure planning and being able to communicate these to the infrastructure planners.
- **What is a successful project?:** Clear results illustrating a ranking of the rail infrastructure development projects by the societal benefits that they provide.
- **Prerequisites:** Infrastructure Planning, GIS and/or programming skills will be recommended. Discussion with Mr. Elvarsson and/or Prof. Adey.

Example: Generation of many possible highway access nodes



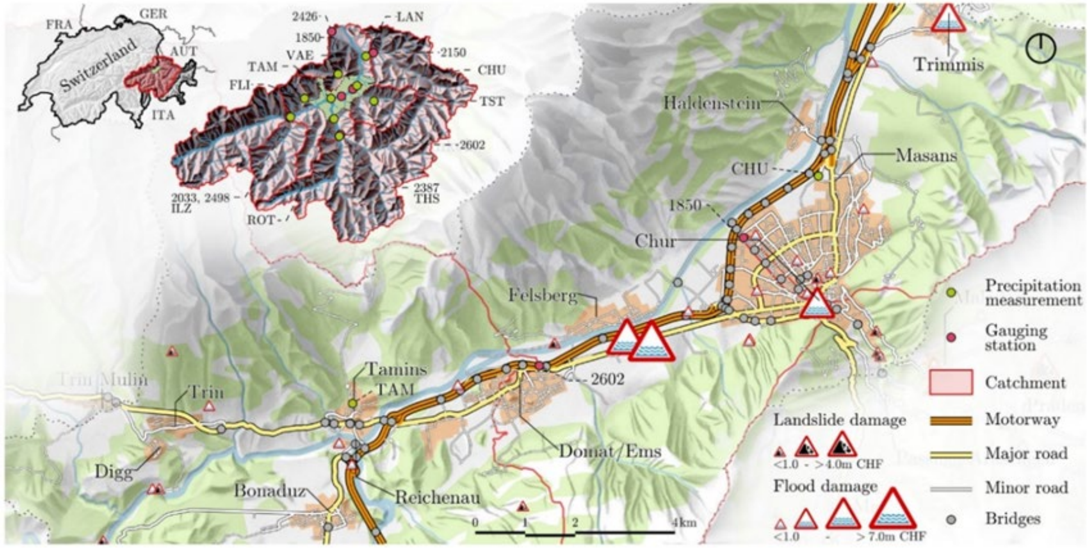
Connected to: (FCL) FUTURE CITIES LABORATORY

ETH zürich

5 – A real time transport system digital twin to minimize risk

Limited to 1

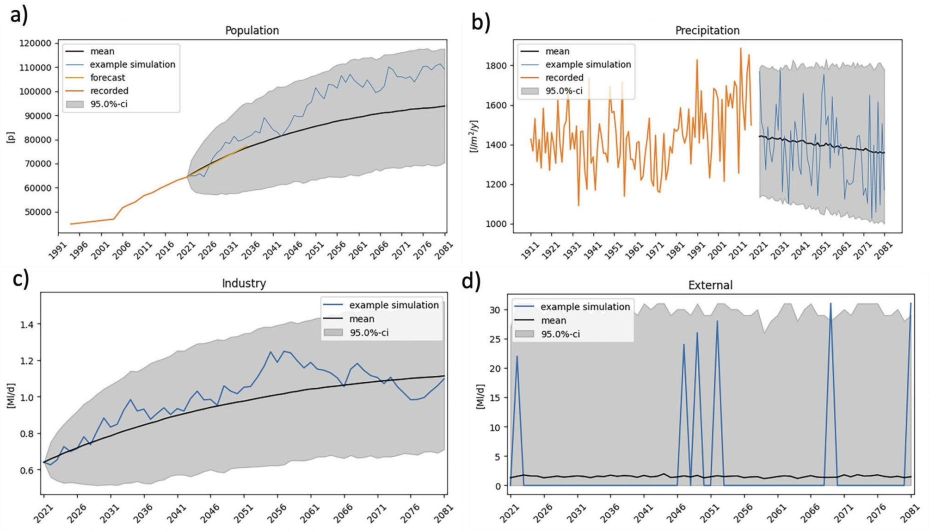
- **Supervisors**: H. Nasrazadani (nasrazadani@ibi.baug.ethz.ch), Dr. Marcelo Torres (gmarcelo@ethz.ch), Prof. Dr. Jürgen Hackl (Princeton), Prof. Dr. B.T. Adey
- **Goal:** To demonstrate how real time information can be used in a digital twin to reduce risk in the region of Chur Switzerland.
- **Main Tasks:** 1) Understand the transport system in Chur, Switzerland, 2) understand/modify the system representation, 3) identify the possible sources of real time information, 4) demonstrably connect the real time information to the system representation or simulations, and 5) demonstrate how the digital twin could be used to reduce risk.
- **What you will learn:** How to use digital twins in the minimization of risk.
- **What is a successful project?** A convincing demonstration that real time information can be used in a spatially distributed digital twin of a transport network to minimize risk.
- **Prerequisites**: Infrastructure Management 1 or Infrastructure Planning; discussion with Mr. Nasrazadani and/or Prof. Adey.



6 – Using a digital twin to facilitate planning water system development

Limited to 1

- **Supervisors**: S. Hässig (haessig@ibi.baug.ethz.ch), Dr. Marcelo Torres (gmarcelo@ethz.ch), Prof. Dr. Jürgen Hackl (Princeton), Prof. Dr. B.T. Adey
- **Goal:** Explain convincingly how a digital twin could be useful in the development of system plans.
- **Main Tasks:** 1) Understand an example water system in Scotland and the decision-making processes of Scottish Water, 2) understand what digital twins are and can be, 3) identify the possible sources of real time information, 4) identify possible sources of uncertainty related to the water system, e.g., rain fall, population, population location, and 5) develop arguments as to how a digital twin could be used including arguments in terms of efficiency and effectiveness of decision making, as well as costs and benefits.
- **What you will learn:** The potential of digital twins in the planning for development of systems.
- **What is a successful project?** A convincing demonstration that real time information can be used in a spatially distributed digital twin of a transport network to minimize risk.
- **Prerequisites**: Infrastructure Management 1 or Infrastructure Planning; discussion with Prof. Adey.

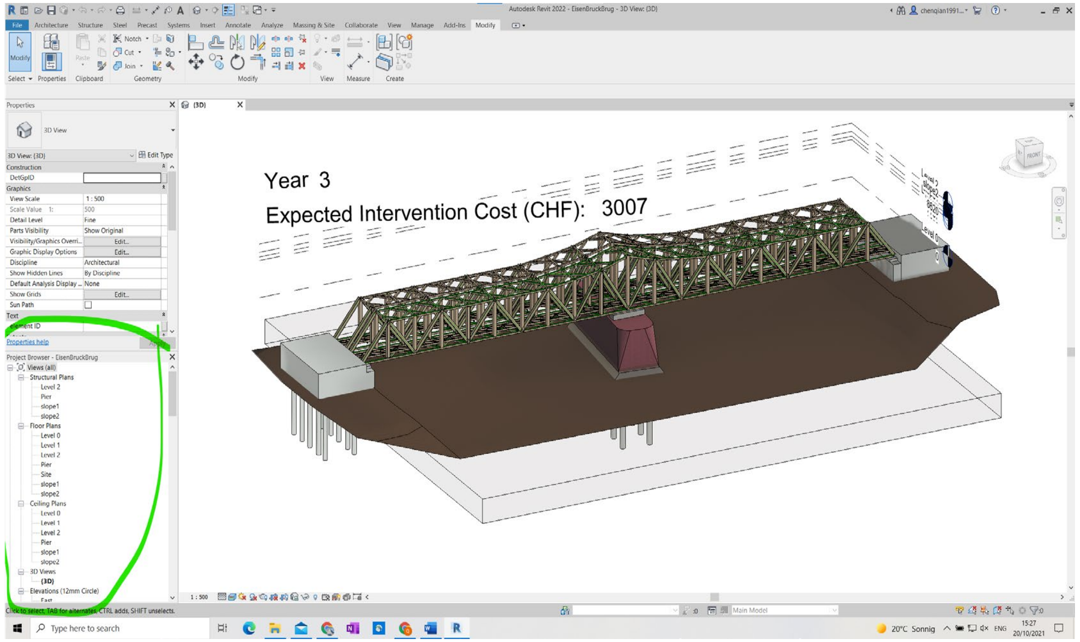


Connected to: Scottish Water

7 – Connecting future predictions to BIM

Limited to 1

- **Supervisors:** S. Hässig (haessig@ibi.baug.ethz.ch), S. Chuo (chuo@ibi.baug.ethz.ch), Prof. Dr. B.T. Adey
- **Goal:** To connect simulation software to BIM.
- **Main Tasks:** 1) Understand how future condition state predictions are made for bridge components, 2) understand how future interventions are predicted, 3) develop a data base which contains this information, 4) connect the database to BIM, 5) illustrate the possible visualisations of the expected deterioration and possible interventions, 6) determine how to best illustrate uncertainty, and 7) develop guidelines for implementation.
- **What you will learn:** How to predict deterioration and failure of bridge components in infrastructure management, how to predict future interventions automatically, and how to connect models to BIM.
- **What is a successful project?** Connection of prediction models to BIM and demonstration of the possible visualization.
- **Prerequisites:** Infrastructure Management 1 or Infrastructure Planning; discussion with Mr. Hässig or Prof. Adey.



Connected to: ASTRA

8 – Estimating missing risk data with Bayesian networks

Limited to 1

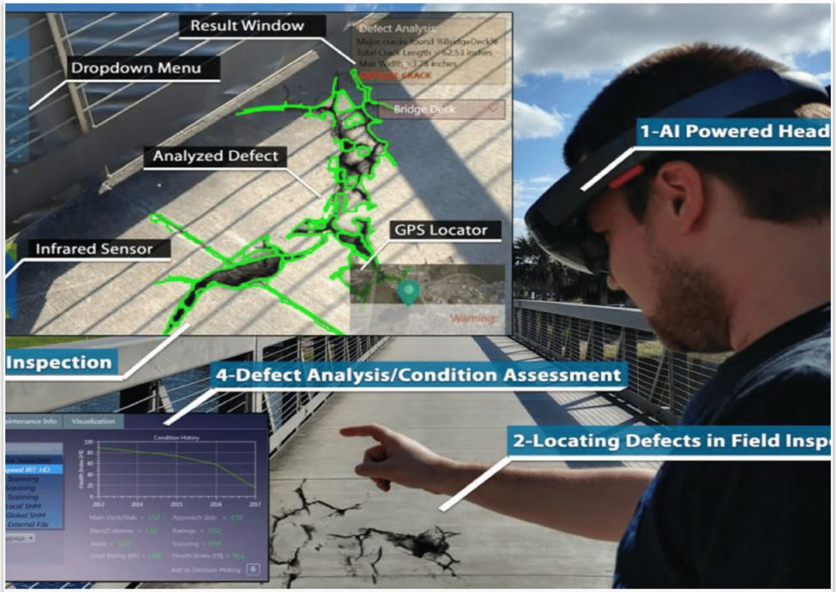
- **Supervisors:** S. Chuo (chuo@ibi.baug.ethz.ch), S. Hässig (haessig@ibi.baug.ethz.ch), Dr. Marcelo Torres, Prof. Dr. B.T. Adey
- **Goal:** To demonstrate how Bayesian networks can be used to estimating missing data for risk estimation for locks and weirs.
- **Main Tasks:** 1) Understand how locks/weirs work, 2) understand how risk estimates are made, 3) develop a tailored risk estimate methodology for the locks/weirs of BAW, 4) identify all information required, 5) adapt an existing methodology from IBI to estimate the required values when there is no data and when there is partial data, and 6) demonstrate how the methodology works on a set of locks/weirs.
- **What you will learn:** How to estimate risk on infrastructure assets, and how to make estimates of missing data using Bayesian Networks.
- **What is a successful project?** A clear demonstration of how good one can estimate missing data using Bayesian Networks to facilitate risk estimates.
- **Prerequisites:** Infrastructure Management 1 or Infrastructure Planning; discussion with Mr. Hässig, Mr. Chuo, or Prof. Adey.

Connected to: BAW, Germany

9 – Use of extended reality of bridge inspections

Limited to 1

- **Supervisors:** Y. An (an@ibi.baug.ethz.ch), S. Hässig (haessig@ibi.baug.ethz.ch), Prof. Dr. Carl Haas (University Waterloo), Prof. Dr. B.T. Adey
- **Goal:** To demonstrate how extended reality and the supporting framework could be used to improve bridge inspection processes.
- **Main Tasks:** 1) Understand how extended reality works, 2) understand how information needs to be structured so that it can be used in extended reality, 3) understand how information needs to be structured so that it is helpful for inspectors and managers to make decisions, 4) understand the different possible ways to display information, 5) learn how to connect information from existing data bases to extended reality devices, 6) determine how current inspection procedures would have to change and could be improved if extended reality was used, and 7) provide an assessment of the advantages and disadvantages of using such a technology.
- **What you will learn:** How extended reality may (or may not) improve bridge inspections.
- **What is a successful project?** A clear demonstration the potential of improvement of bridge inspection processes through the use of extended reality.
- **Prerequisites:** Infrastructure Management 1; discussion with Prof. Adey.



Connected to: SBB

10 – Asset management approaches to enable resilience

Limited to 1

- **Supervisors:** D. Zani (zani@ibi.baug.ethz.ch), J. Meier (meier@ibi.baug.ethz.ch, Dr. Marcelo Torres, Prof. Dr. B.T. Adey
- **Goal:** To provide an example asset management approach that would help ensure network resilience.
- **Main Tasks:** 1) Understand the main components of an asset management approach, 2) understand the main components required to estimate resilience, 3) outline an asset management approach for a railway bridge, 4) collect data to be used to make the asset management approach as realistic as possible, 5) make an asset management approach for a specific type of railway bridge, and 6) make a plan to collect all data required to make the perfect asset management approach and rank the data collection in order of descending importance.
- **What you will learn:** How to make an asset management approach, and how to make an asset management approach to enable resilience.
- **What is a successful project?** An example of an asset management approach to enable resilience that is convincing to bridge managers.
- **Prerequisites:** Infrastructure Management 1; discussion with Prof. Adey.

Connected to: SBB