

# Visual-Acoustic 3D Landscapes

## for assessing wind farm scenarios

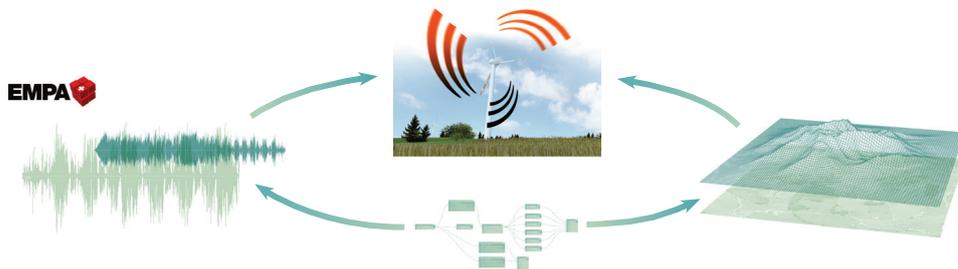


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How can the impact assessment of planned wind farms on the landscape be enhanced in order to determine socially accepted locations? By integrating realistic acoustic soundscape modeling and GIS-based 3D landscape visualizations.

Based on field recordings of a wind farm in Switzerland, an acoustic simulation of the wind turbine noise was developed and linked to a visual simulation of 3D landscapes. Furthermore, the simulation's validity was evaluated for landscape assessment.

## Linking Acoustics to 3D Landscapes



### Acoustic Simulation

Based on recordings taken at modern 2MW turbines, an audio synthesizer was developed in the software MATLAB to generate emission sound files for different wind speeds. An additional software module implements a set of digital filters to model all relevant propagation effects from the emission point to an arbitrary location in the landscape.

The acoustic simulation was developed in collaboration with the Swiss Federal Laboratories for Material Science and Technology, EMPA.

### Linking Parameters

Specific parameters are defined in both simulations, providing a correct connection:

- Wind speed /direction,
- Wind turbine position/ rotation frequency
- Receiver position/ viewing direction

These parameters are linked via a logical algorithm developed in the CryENGINE flow graph environment.

### Visual Simulation

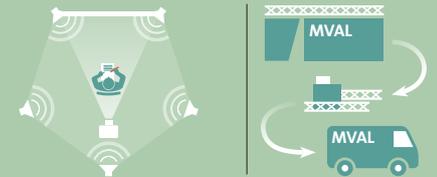
An interactive 3D landscape simulation with high level of detail based on a digital elevation model and an orthophoto is generated, using the Sandbox-Editor of Crytek's CryENGINE 3.

Objects of landscape elements such as vegetation and 3D models of wind turbines were added according to the corresponding coordinates of their actual locations.



## Validation

To present the simulations a mobile visual acoustic lab (MVAL) was developed to stabilize and control the visual-acoustic environment, and to perform experiments in arbitrary locations.



Mobile visual acoustic lab (MVAL)

The participants rated the perception of real and simulated landscapes, presented as videos in the MVAL.

### Validation set-up:

- 10 Videos (5 real, 5 simulations) were randomly shown (15 sec. each)
- A questionnaire was filled out for each video
- Perception: Rating of the annoyance by the wind turbine noise and the liking of the landscapes on a 10-point likert scale
- Statistic Design: A Linear Mixed Effects Model

## Output: Visual-Acoustic 3D Landscapes

With the developed visual-acoustic simulation different wind farm scenarios can be generated. The user is able to go to any location in the visualization in order to explore the visual and acoustic situation of the scenarios. Moreover the lighting and the daytime can be changed interactively so that the scenery can be experienced at night time as well.

### Visual-Acoustic 3D Landscapes



### Corresponding Real Landscapes



## Results

The simulated landscapes are perceived similarly as the real landscapes. The simulation can be accepted and applied in further experiments!

## Outlook

The combined visual and acoustic simulations will be applied in **acceptability studies** in the mobile visual acoustic lab in different communities in Switzerland. The results will allow to derive recommendations for planning wind farms and support exploiting the full potential of wind energy.