GMSimViz: Automated 3D Visualization of Ground Motion Simulation and Consequent Impacts

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1. Overview

GMSimViz is an automation tool that produces an animated 3D visualization of geological faults, ground motion and other earthquake-related data. Typically verification of ground motion simulations involves various data visualization methods, and a 3D animation is an excellent medium to understand the nature of an earthquake. It also helps to communicate with the general public, but its production has been largely left to time-consuming manual interaction with no existing automation tool available. GMSimViz was created to fulfill this need and produces a quality 3D animation directly from the simulation data in a fully automated way. GMSimViz is published on GitHub under MIT license. A video of the result of GMSimViz is also available on Youtube(please see '5. External Sources' at the bottom for URLs and QR codes).

Figure 1: Tools Leveraged

2. Tools Leveraged

- **Generic Mapping Tools** (GMT) to create individual frames. GMT is a collection of command line interface programs. Creating a fully featured 3D animation with a high frame rate often involves execution of millions of GMT commands. GMSimViz has a Python wrapper to help automate the rendering process through scripting. Various visual effects such as tilt and rotation of the view and fading in/out of different elements are fully automated. The view window and related variables such as viewing angle, center, level of zoom etc. are determined algorithmically based on the data extracted from the input files. GMSimViz extends the 3D support provided by GMT by using GMT datum to projection coordinate conversion. This allows plotting vertical or near-vertical surfaces in any orientation. The output animation primarily contains the view of geological faults and ground motion. Users can optionally add map data for liquefaction and landslide probability as well as road network status data.
- **FFmpeg Video Editing** built with image2/png, H.264 encoder support to join frames and create a video.
- **Message Passing Interface** (MPI) to utilize a multi-core computer or High Performance Computing (HPC) facilities. The rendering process of GMSimViz is computationally intensive, yet provides an excellent opportunity to compute in parallel.
- **Python Numpy library** for fast and efficient mathematical computations.

3. Computational Components

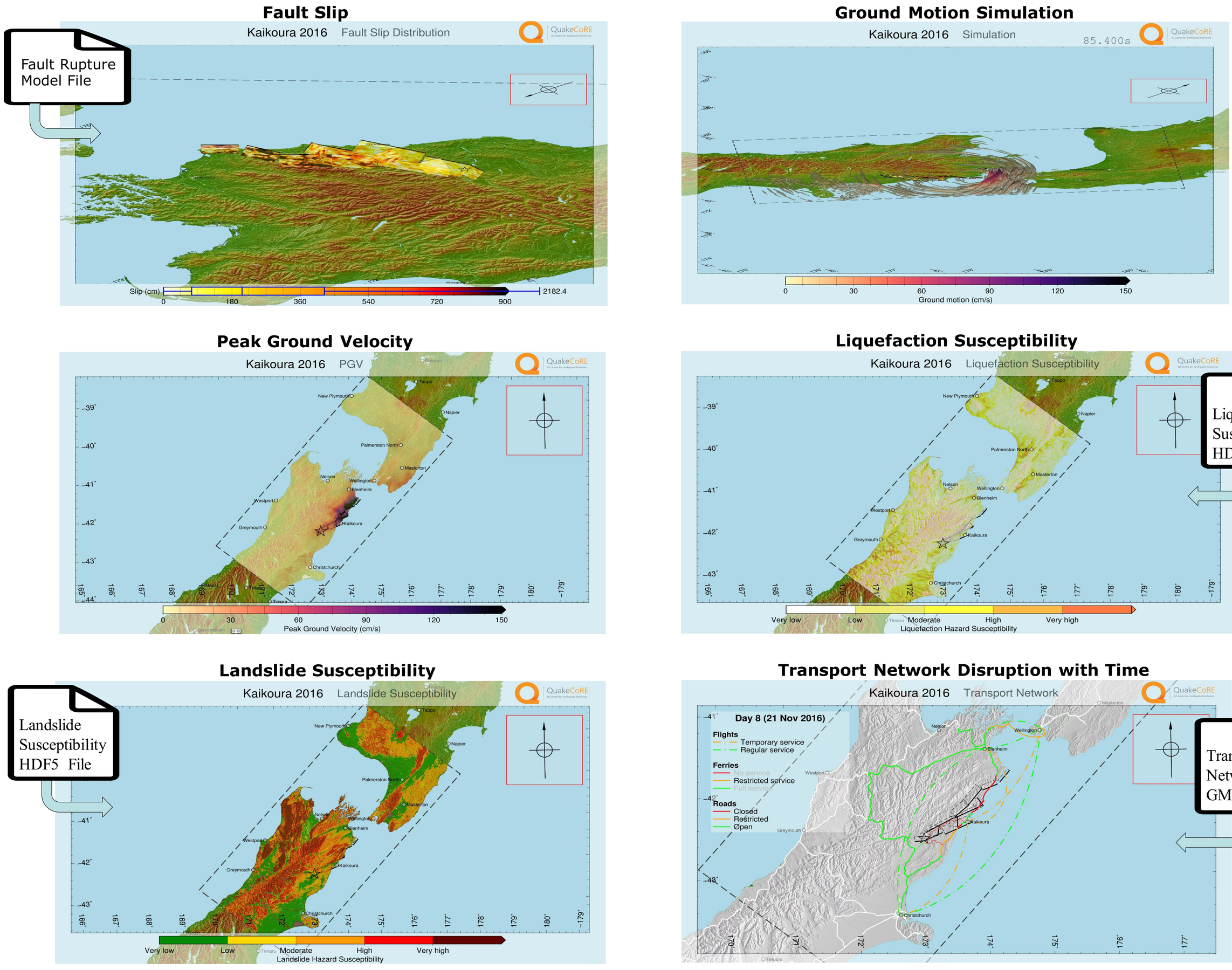

Figure 2: Visulization of Computational Components

4. Future Development

- **Extend visualization functionality:** This is to display other 'downstream' calculations such as building demand and socio-economic metrics.
- **Increase computation speed:** Currently, it takes a typical PC about 2,500 core hours to produce the demonstration animation. The topography generation needs to be optimized as it takes up most of the time.
- **Optimize view window**: This includes contents, zoom level and overlay z-scaling(scaling of the 3D overlay velocity wave to make sure it does not go off the screen) in all cases of earthquakes. The optimization could be carried out by running the main script with various small and large earthquakes, and determining factors that work in all cases.

5. External Sources

- **Source code**: https://github.com/ucgmsim/GMSimViz
- **Video**: https://youtu.be/qZkOTI4x_cc