Scenario Visualization with the ‘Ike Wai Hawai’i Groundwater Recharge Tool

Jared McLean¹, Sean Cleveland¹, Kolja Rotzoll², Scot Izuka², Gwen Jacobs¹

¹University of Hawai‘i ITS Cyberinfrastructure, ²U.S. Geological Survey, Pacific Islands Water Science Center

Introduction

The primary purpose of this application is to visualize the effects of land-cover alterations on groundwater-recharge rates for the island of O‘ahu, Hawai‘i. Users can define and modify the land cover of an area of the island. Based on user-defined land-cover types and available rainfall data or projections, the application will display various metrics respective to the estimated impacts on the island’s groundwater-recharge rates. This application simplifies the process of evaluating recharge changes linked to land-cover and climate changes and provides rapid results and metrics that are useful in research and water-management decision making.

Visit the Hawai‘i Groundwater Recharge Tool

https://recharge.ikewai.org/

Application Outcomes

• Recharge visualization displays various metrics.
  • Baseline and modified recharge rates in millions of gallons/liters per day or inches/millimeters per year.
  • Area of selection.
  • Difference and percent change in recharge for the selected area.

• Several different metrics modes:
  • Aquifer based
  • User-defined area based
  • Individual cell based
  • Island-wide based

• Areas of caprock can be included or excluded from metric computations.
• Users can generate a report window containing a breakdown of metrics for all aquifers, user-defined areas, and the map as a whole, along with bar graphs representing the change in recharge for each area.
• Land cover and groundwater-recharge rasters can be exported from the application in ASCII or CoverageJSON formats, user-defined areas can be exported as shapefiles, and reports can be exported as a PDF.

Future Work

• Extension of application to other islands
• Additional rainfall scenarios
• Improved memory utilization to allow for better translation to larger data sets
• Finer grid resolution

Approach

• Uses a multiple-document interface embedded in a webpage to allow users to easily view and manipulate multiple scenarios within a single context.
• Primary window type displays a map of the island of O‘ahu containing swappable overlays:
  • Land-cover type
  • Recharge rate
  • Base satellite view

• Land-cover type and recharge rates are given at a 75 meter x 75 meter resolution, with values given as a grid over the provided region.
• Aquifer boundaries (management areas) and regions of caprock for the island are available as toggleable overlays.
• Land-cover portion of the visualization offers users the ability to draw area boundaries or select individual cells within the map and modify the land cover.
• Land-cover modifications can be uploaded as an ASCII grid or CoverageJSON format containing land-cover codes or shapefiles with a land-cover code property.
  • Supports subsets or offsets in gridded data so long as data is contained within the defined map area.
  • Shapefiles can be uploaded to the map as user-defined area boundaries or a toggleable reference layer.
• 29 different land-cover types currently supported by the application.
• Two different rainfall scenarios are available:
  • Baseline rainfall based on data collected between 1978 and 2007.
  • Rainfall projections for the years 2041-2070 (RCP 8.5).
• Groundwater-recharge data was generated using the soil water-balance computer program SWAT version 2.0 (Westenbroek and others, 2018):
  • Simulation data is stored in a MongoDB database.
  • Modifications to land cover in the application trigger a request for the respective groundwater-recharge values.

Acknowledgments: Support for the Hawai‘i EPSCoR Program is provided by the National Science Foundation’s Research Infrastructure Improvement (RII) Track-1: ‘Ike Wai: Securing Hawai‘i’s Water Future Award # OIA-1557349; Project Tapis: Next Generation Software for Distributed Research NSF CSSI #1931439, #1931575.

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.