

Exponent®
Engineering & Scientific Consulting

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Professional Profile

Dr. Adrian Mikhail P. Garcia has expertise in hydrodynamics, surface and groundwater hydrology, and transport processes in the environment. He specializes in using numerical modeling, field observations, and remote sensing techniques to understand complex fluid mechanics processes in the built and natural environment, and to support assessments of environmental impacts and regulatory compliance.

Dr. Garcia's research focused on the influence of physical elements on the hydrodynamics of the coastal zone. During his doctoral studies at the Massachusetts Institute of Technology and Woods Hole Oceanographic Institution, he designed field experiments and built computational models to understand physical controls on saltwater intrusion in a tidal estuary with complex topography. By applying a novel Lagrangian analysis to numerical simulations of an estuary, he demonstrated the dominant role of topographically induced dispersion on the horizontal transport of waterborne constituents (e.g., salt) in tidal environments. These results provide insights into how future infrastructure projects can influence circulation patterns in the coastal zone. Additionally, Dr. Garcia has conducted laboratory experiments which determined that mangrove forests increase the effective drag coefficient by 2–3 orders of magnitude compared to bare seabeds, thereby reducing wave energy and providing a form of nature-based coastal protection. This research highlights the important role of mangroves and other elements of green infrastructure in mitigating the impacts of storm surge and rising sea levels due to climate change.

Dr. Garcia's skillset includes applying analytical and numerical methods (e.g., CORMIX) to evaluate mixing, dispersion, and transport processes in the environment; using 3-dimensional hydrodynamics models such as Delft3D, Environmental Fluid Dynamics Code (EFDC), and the Regional Ocean Modeling System (ROMS); assessing groundwater flow and contaminant transport using Darcy's law and models such as MODFLOW; evaluating the exchange of groundwater and surface water flows in the hyporheic zone; analyzing time-series from observational datasets and multidimensional model output files; conducting geospatial analysis in Python, QGIS, and ArcGIS; evaluating hydraulic designs based on engineering calculations and physical principles; and modeling 1-dimensional river hydraulics and surface hydrology using HEC-RAS and HEC-HMS.

Academic Credentials & Professional Honors

Ph.D., Civil and Environmental Engineering, Massachusetts Institute of Technology (MIT), 2022

B.S., Civil Engineering, University of Pittsburgh, 2016

National Science Foundation, Graduate Research Fellow, 2019–2022.

MIT Diversity Fellow, Massachusetts Institute of Technology (MIT), 2017–2018.

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Michael J. Kowalski Fellow in Ocean Engineering, Woods Hole Oceanographic Institution (WHOI), 2017–2018.

Licenses and Certifications

Professional Engineer Civil, Oregon, #108732PE

Professional Engineer Civil, Washington, #26028161

Prior Experience

Post-doctoral Investigator, Woods Hole Oceanographic Institution (WHOI), 2022

Languages

Spanish

Publications

Abad, J. D., A. P. Garcia, J. Marín□Díaz, C. Escobar, C. Ortals, and H. Chicchon. 2024. Morphodynamics of anabranching structures in the Peruvian Amazon River. Earth Surf. Process. Landf. 50(1):e6020. https://doi.org/10.1002/esp.6020

Bo, T., D.K. Ralston, A.M.P. Garcia, and W.R. Geyer. 2024. Tidal intrusion fronts, surface convergence, and mixing in an estuary with complex topography. J. Phys. Oceanogr. 54(3):653–77. https://doi.org/10.1175/JPO-D-23-0131.1

Garcia, A.M.P., and W.R. Geyer. 2023. Tidal dispersion in short estuaries. J. Geophys. Res. Oceans 128(2):1–21. https://doi.org/10.1029/2022jc018883

Garcia, A.M.P., W.R. Geyer, and N. Randall. 2021. Exchange flows in tributary creeks enhance dispersion by tidal trapping. Estuar. Coast. 45(2):363–81. https://doi.org/10.1007/s12237-021-00969-4

Kranenburg, W.M., W.R. Geyer, A.M.P. Garcia, and D.K. Ralston. 2019. Reversed lateral circulation in a sharp estuarine bend with weak stratification. J. Phys. Oceanogr. 49(6):1619–37. https://doi.org/10.1175/JPO-D-18-0175.1

Maza, M., K. Adler, D. Ramos, A.M. Garcia, and H. Nepf. 2017. Velocity and drag evolution from the leading edge of a model mangrove forest. J. Geophys. Res. Oceans 122(11):9144–59. https://doi.org/10.1002/2017JC012945

Dickerson, S.J., S.P. Jacobs, A.M. Garcia, and D.V.P. Sanchez. 2016. Joint assessment and evaluation of senior design projects by faculty and industry. pp. 1–7. In: IEEE Frontiers in Education Conference, Erie, PA, October 12–15, 2016. https://doi.org/10.1109/FIE.2016.7757395

Presentations

Garcia, A. M. P. 2023. Topographically induced dispersion in a tidal estuary (invited talk). Rutgers University, New Brunswick, NJ, January 30, 2023.

Garcia, A.M.P., and W.R. Geyer. 2022. Tidal dispersion due to flow separation in estuaries (oral presentation). Ocean Sciences Meeting, Virtual, February 24–March 4, 2022.

Garcia, A.M.P. 2022. Dispersion due to flow separation in estuaries (invited talk). University of

Washington, Seattle, WA, February 7, 2022.

Garcia, A.M.P. 2022. Dispersion due to flow separation in a tidally dominated estuary (invited talk). Woods Hole Oceanographic Institution, Woods Hole, MA, February 4, 2022.

Garcia, A.M.P., and W.R. Geyer. 2021. Nonlocal dispersion dominates the salt balance in short estuaries (oral presentation). Coastal & Estuarine Research Federation, Virtual, November 7–11, 2021.

Garcia, A.M.P. 2021. Dispersion in tidally dominated estuaries (invited talk). Stanford University, Pasadena, CA, October 15, 2021.

Garcia, A.M.P. 2020. Dispersion in a salt marsh estuary (invited talk). Massachusetts Institute of Technology, Cambridge, MA, July 17, 2020.

Garcia, A.M.P., and W.R. Geyer. 2020. Dispersion by tidal trapping is enhanced by stratification (oral presentation). Ocean Sciences Meeting, San Diego, CA, February 16–21, 2020.

Garcia, A.M.P., N. Randall, W.R. Geyer, W.M. Kranenburg, and D.K. Ralston. 2018. Effect of tributary creeks on estuarine dispersion (poster). American Geophysical Union, Washington, DC, December 10–14, 2018.

Garcia, A.M.P., and H.M. Nepf. 2016. An experimental study of an artificial mangrove forest: Determination of drag and turbulence (oral presentation). Society of Hispanic Professional Engineers: Engineering Science Symposium, Seattle, WA, November 2–6, 2016.

García, A.M.P., and J.D. Abad. 2016. La evolución morfodinámica del Río Amazonas peruano: Un análisis planimétrico (oral presentation). Congreso Lationamericano de Hidráulica, Lima, Perú, September 28–30, 2016.

Garcia, A.M.P., J.D. Abad, C. Ortals, and C.E. Frias. (2014). Insight on the Peruvian Amazon River: A Planform Metric Characterization of its Morphodynamics (poster presentation). American Geophysical Union, San Francisco, CA, December 15–19, 2014.

Project Experience

Dilution studies

Conducted CORMIX simulations to calculate near-field mixing and dilution of produced water (oilfield brine) discharged into a brackish tidal marsh environment. Analyzed long-term historical environmental data using a mass balance approach to estimate far-field dilution and impacts to ambient marsh salinity.

Synthesized key concepts and physical principles from scientific literature to assess dilution processes impacting the spatial distributions of measured metals concentrations from the porewater below the surface of the streambed up to the overlying river water.

Reviewed EFDC model setup of multiple industrial outfalls discharging into a river and compared 3-D model results of dilution rates with CORMIX solutions for near-field mixing. Developed Python script for reading and analyzing binary Fortran files from EFDC model output.

Developed and validated a Delft3D model of a shallow bay adjacent to a tidally forced channel to determine tidal circulation patterns and to evaluate dilution of a discharge into the bay.

Conducted dilution analysis using MAMPEC and CORMIX models to evaluate discharges into the marine environment under a range of hydrodynamic conditions.

Oil spills

Evaluated fate and transport of LNAPL from a subsurface pipeline release using Darcy's law and hydrogeological site data to assess start date of release.

Co-led development of an OSCAR oil spill simulation model to recreate fate and transport of oil in a coastal lagoon environment, as part of a Natural Resource Damage Assessment (NRDA). Developed Python script to process and analyze 4-dimensional (x, y, z, time) data structures from NetCDF files.

Hydraulic design

Conducted hydraulic conveyance calculations based on digital elevation models and satellite imagery to assess impact of residential renovations on flood risk.

Evaluated runoff from a steep, developed watershed using the rational method. Conducted hydraulic conveyance analyses based on a LiDAR scan of a sidewalk and roadway to estimate flooding impacts to a residential property.

Reviewed historical documents, construction drawings, engineering calculations, and HEC-RAS 2D model files to assess stormwater drainage design.

Conducted HEC-RAS 1D model simulations based on a review of construction drawings, historical documents, and site data to evaluate flooding under pre- and post-project conditions for a bridge crossing through a FEMA floodplain.

Calculated a water balance to track movement of water in a treatment facility based on a review of historical documents, engineering drawings, SCADA reports, and time-series measurements.

Conducted validation of InfoWorks ICM model results against measured observations of flowrates and water levels to assess model accuracy in reproducing flooding of wastewater collection system.

Groundwater modeling

Applied the EPA 3PE tool to calculate local groundwater flow direction using historical monitoring well data to evaluate source location for a groundwater plume.

Mapped surface water transactions and groundwater extraction rates onto a conceptual mass balance model to quantify and assess both present and future aquifer conditions in support of a groundwater sustainability plan.

Constructed interactive 3D plume visualizations from scatter clouds of groundwater chemistry sample data using Python.

Evaluated AT123D groundwater transport simulations of a TCE plume at a Superfund site. Applied statistical analyses to quantify uncertainty in travel time calculations based on variability of hydrogeologic parameters in a coastal aquifer.

Applied analytical solutions of groundwater transport to evaluate potential sources of a TCE plume from an industrial manufacturing facility.

Reviewed regional hydrogeologic parameters and groundwater flow patterns from scientific reports and monitoring data to evaluate potential impacts of landspreading in agricultural fields on groundwater nitrate contamination.

Reviewed historical documents, witness testimonies, and scientific reports to identify potential PFAS source areas and possible migration pathways in a shallow aquifer.

Conducted historical simulations of groundwater flow and contaminant transport using MODFLOW and MT3DMS in support of Superfund litigation. Evaluated contaminant pathways based on particle tracking by using MODPATH.

Compliance

Reviewed permits, compliance documents, and topography maps to evaluate environmental impacts of sediment loading from an engineered haul road to local mountain streams.

Environmental data analytics

Developed Python scripts to download, process, and visualize multi-dimensional rainfall data from Multi-Radar/Multi-Sensor Systems (MRMS) to evaluate spatial patterns of precipitation and potential risks to utilities infrastructure.

Analyzed sediment sample data from a Superfund site using Positive Matrix Factorization (PMF) and chemical fingerprinting (i.e., “unmixing” methods) based on non-negative least squares estimation. Created geospatial data visualizations using Python.

Validated emissions calculations from exhaust gas cleaning scrubber (EGCS) systems against a compiled global dataset of shipboard measurements.

Saltwater intrusion and estuarine water quality

Conducted and evaluated model runs using the California Department of Water Resources (DWR) Delta Simulation Model II (DSM2) to quantify hydrodynamics and water quality impacts (e.g., salinity, HABs) from future water diversion projects and climate change in the Sacramento/San-Joaquin Delta.

Identified the role of marsh-channel exchange on horizontal dispersion in a salt marsh estuary with complex topography by applying a novel Lagrangian method to model output from the Regional Ocean Modeling System (ROMS).

Evaluated physical controls on saltwater intrusion in a tidal estuary by using a numerical model to determine the dependency of various transport processes on river flow and tidal conditions.

Demonstrated a linkage between stratification in secondary channels and circulation patterns in the main channel of an estuary by designing and conducting field experiments using moored instruments, shipboard surveys, and aerial drone imagery to measure tides, currents, and salinity.

Coastal protection

Quantified the effect of vegetation on wave damping by conducting laboratory experiments to measure the quadratic drag coefficient in an artificial mangrove forest.

Dam removal

Assessed the impacts of a dam removal on the water level of a small creek by using HEC-RAS and HEC-HMS to model the local hydraulics and hydrology.

Additional Education & Training

Estuarine and Coastal Fluid Dynamics (OCEAN 590), Friday Harbor Laboratories, University of Washington, 2019

Peer Reviews

Journal of Geophysical Research

Journal of Physical Oceanography