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Application Summary

Competition Details

Competition Title:	Black Trailblazers in Engineering
Category:	Events and Conferences
Submission Deadline:	1/29/2021 11:59 PM

Application Information

Submitted By:	Mohammed Ombadi
Appplication ID:	1485
Application Title:	PhD Candidate, University of California Irvine
Date Submitted:	12/13/2020 3:04 PM

Personal Details

First Name:	Mohammed
Last Name:	Ombadi
Title:	PhD Candidate, University of California Irvine
Email address:	mombadi@uci.edu
Phone number:	9499810969
PhD Institution:	University of California Irvine
Date or Expected Date of PhD:	06/2021
Engineering Discipline:	Civil & Environmental
Current Institution:	University of California Irvine

Application Details

Acknowledgment

Acknowledgement of BTE Program Requirements

[Acknowledged] If selected as a BTE Fellow, I will be available to attend all workshop sessions on the follow dates and times:

Feb. 24, 12:00 - 8:00 pm ET

Feb. 25, 12:30 - 8:00 pm ET

Feb. 26, 12:00 - 8:00 pm ET

Feb. 27, 12:00 - 4:30 pm ET

In addition to being available to virtually attend the above sessions in their entirety, other requirements for participation in BTE include the program elements listed below:

- Ability to create and share a poster for a virtual poster session
- Willingness to share life experiences and your passion for a career in Engineering
- Completion of pre- and post-workshop surveys
- Permission to be featured on a BTE webpage that will be promoted to other Engineering institutions

A $500 scholarship will be awarded, pending full participation in the workshop

Ombadi, Mohammed – Cover Letter

December 13, 2020

2721 Verano Place

Irvine, CA 92617

Dear Members of the selection committee,

My name is Mohammed Ombadi, and I'm a PhD candidate at the department of Civil and Environmental Engineering at University of California Irvine. I'm currently at the final year of my PhD, and it is expected that I will defend my dissertation by June 2021.

I'm primarily interested in this program because I plan to apply to faculty positions in the near future, and I think that this program will provide me with a unique opportunity to prepare for the application process. Furthermore, I will relish the opportunity to interact and network with leading black engineering faculty and program managers. I have no doubt that developing such a network will prove to be fruitful regarding future opportunities in multidisciplinary research as well as promoting diversity and inclusion in higher education.

My experiences as a black and international PhD student in a science, technology, engineering and mathematics (STEM) field provided me with a unique opportunity to understand the importance of diversity and the challenges that face underrepresented minorities in educational environments. As a graduate student at UCI, I had the opportunity to serve as a teaching assistant twice, attend the Mentoring Excellence Program (MEP) offered by the Graduate Division, mentor incoming international students, and participate in activities organized by the National Society of Black Engineers (NSBE). Each of which provided me with an opportunity to interact with individuals from various underrepresented groups, and I was lucky to learn a lot from them. I aspire for a career in research and academia that on one hand would satisfy my passion for research, and on the other hand would allow me to contribute to diversity in higher education. A career through which I can pass on the lessons I learned on diversity, raise awareness of biases toward minorities, address differences openly, and provide a role model for a younger generation of people of color in STEM fields.

I hope you will consider my application favorably, and I thank you in advance for your time and consideration.

Sincerely,

Mohammed Ombadi.

Ombadi, Mohammed – Research and Education Plan

Research Plans

Hydrometeorological systems are characterized by complex interactions that manifest only at specific, discrete and dominant spatiotemporal scales. Hence, the empirical relationships formulated at a given scale are often invalid across the hierarchy of scales. It has long been argued that significant advances in hydrology are greatly hindered by our inability to comprehend and formulate concepts at scales outside the scope of our human sensory scale. The traditional approach in contemporary hydrology is reductionist in its essence and seeks to obtain predictive understanding of hydrologic processes at the macroscale based on models that aggregate theoretical and empirical knowledge at smaller scales. This approach often suffers from its incapacity to recognize synergy and interference that often lead to emergent behaviors at macroscales, and it is imperiled by our incomplete knowledge of the heterogeneities that exist at fine scales.

In my future research, I plan to build on my current PhD research work and use state-of-the-art methods of causal inference and data mining to offer an alternative and complementary paradigm to the contemporary reductionist approach. Generally speaking, methods of causal inference are rooted in networks, information and chaos theories, and they can be utilized in tandem with observational datasets to detect regularities and patterns at macroscales. They are particularly effective in detecting complex interactions among variables in dynamical systems solely from observational datasets, and they proved to be fruitful in a wide range of fields such as economics, neuroscience and epidemiology. Two specific research questions that I intend to examine thoroughly at UC Berkeley using these methods are: (1) what is the differential impact of precipitation amounts, precipitation form (rain vs snow) and temperature in driving the reported trends of earlier spring snowmelt in Western United States? (2) To what extent are climate models accurate in representing land-atmosphere interactions? The first research question attempts to unravel the complex cause-effect relationship that underlies the reported trends of earlier spring snowmelt in Western US, and it is of paramount importance to management of water resources in Western US. The second research question attempts to leverage the advantage of causal inference methods of extracting interaction patterns from observational datasets, and subsequently contrasts them with those obtained from climate models. This latter proposed research epitomizes the complementary nature of the methods I intend to use; specifically, the possibility of using causal inference to confront models with observations.

The potential outcomes of my proposed research include improved understanding of past trends in the hydrologic cycle of Western US and offering a meaningful way to predict how these trends will change in response to climate change. Moreover, the second research question which aims to confront climate models with observations will potentially result in improving the representation of land-atmosphere interactions in climate models — a key component of climate models that is widely believed to be responsible of the biases in climate models' simulations. Overall, both research questions have far-reaching consequences of societal relevance due to the vital role of the hydrologic cycle in the functioning of ecosystems, the resilience of infrastructure and the wellbeing of humankind. More importantly, the proposed research because of its novelty may represent a paradigm shift and potentially streamline the use of causal inference to address a wide

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range of problems in hydrometeorology. This is particularly opportune due to the rapid accumulation of in-situ and remotely sensed observations as well as climatological reconstructions and field campaigns.

Education Plans

In my point of view, I believe that it is important for every researcher to be involved in teaching and education. This is because many of the skills developed through teaching such as effective communication skills are quite important for achieving progress in research. For instance, the ability to put oneself in student's shoes, to detach from the expert knowledge in a particular field, and to understand the challenges that will face a novice in the field is a very valuable skill when conducting and communicating research — as Albert Einstein said "If you can't explain it simply, you don't understand it well enough". Thus, as a future faculty, I plan to dedicate a sizable proportion of my time to teaching activities.

Furthermore, motivated by my educational background and experiences, I plan to analyze enrollment of people of color and the barriers that they face in my specific field of hydrology, and more broadly in earth sciences. In addition to my involvement in academia, this will be facilitated through my current activity in professional societies such as the American Meteorological Society (AMS); see my curriculum vitae.

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Mohammed Ombadi

mombadi@uci.edu | ResearchGate | Google Scholar

Education

University of California Irvine, PhD in Civil & Environmental Engineering, Current (Expected June 2021) – Advisor: Soroosh Sorooshian
University of California Irvine, MSc in Civil Engineering (Hydrology and Water Resources), 2017
University of Khartoum, BSc in Civil Engineering, 2014

Publications

1. **Ombadi, M.**, Nguyen, P., Sorooshian, S., & Hsu, K. L. (2020), Retrospective Analysis and Bayesian Model Averaging of CMIP6 Precipitation in the Nile River Basin. **Journal of Hydrometeorology.** https://doi.org/10.1175/JHM-D-20-0157.1

2. **Ombadi, M.**, Nguyen, P., Sorooshian, S., & Hsu, K. L. (2020). Evaluation of methods for causal discovery in hydrometeorological systems. **Water Resources Research**, 56(7), e2020WR027251, https://doi.org/10.1029/2020WR027251

3. **Ombadi, M.**, Nguyen, P., Sorooshian, S., & Hsu, K. L. (2018). Developing Intensity-Duration-Frequency (IDF) Curves From Satellite-Based Precipitation: Methodology and Evaluation. **Water Resources Research**, 54(10), 7752-7766, https://doi.org/10.1029/2018WR022929

4. Nguyen, P., **Ombadi, M.**, Sorooshian, S., Hsu, K., AghaKouchak, A., Braithwaite, D., ... & Thorstensen, A. R. (2018). The PERSIANN family of global satellite precipitation data: A review and evaluation of products. **Hydrology and Earth System Sciences**, 22(11), 5801-5816, https://doi.org/10.5194/hess-22-5801-2018

5. Nguyen, P., **Ombadi, M.**, Gorooh, V. A., Shearer, E. J., Sorooshian, S., Hsu, K., Bolvin, D., & Ralph, M. F (2020). PERSIANN Dynamic Infrared-Rain Rate (PDIR-Now): A Near-real time, Quasi-Global Satellite Precipitation Dataset. **Journal of Hydrometeorology.** https://doi.org/10.1175/JHM-D-20-0177.1

6. Nguyen, P., Shearer, E. J., **Ombadi, M.**, Gorooh, V. A., Hsu, K., Sorooshian, S., ... & Ralph, M. (2020). PERSIANN Dynamic Infrared–Rain Rate Model (PDIR) for High-Resolution, Real-Time Satellite Precipitation Estimation. **Bulletin of the American Meteorological Society**, 101(3), E286-E302, https://doi.org/10.1175/BAMS-D-19-0118.1

7. Tran, H., Nguyen, P., **Ombadi, M.**, Hsu, K. L., Sorooshian, S., & Qing, X. (2019). A cloud-free MODIS snow cover dataset for the contiguous United States from 2000 to 2017. **Nature Scientific data**, 6, 180300, https://doi.org/10.1038/sdata.2018.300

8. Tran, H., Nguyen, P., **Ombadi, M.**, Hsu, K., Sorooshian, S., & Andreadis, K. (2019). Improving hydrologic modeling using cloud-free MODIS flood maps. **Journal of Hydrometeorology**, 20(11), 2203-2214, https://doi.org/10.1175/JHM-D-19-0021.1

9. Nguyen, P., Shearer, E. J., Tran, H., **Ombadi, M.**, Hayatbini, N., Palacios, T., ... & Kuligowski, B. (2019). The CHRS Data Portal, an easily accessible public repository for PERSIANN global satellite precipitation data. **Nature Scientific data**, 6(1), 1-10, https://doi.org/10.1038/sdata.2018.296

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10. Sorooshian, S., Gorooh, V. A., Hayatbini, N., **Ombadi, M.**, Sadeghi, M., Nguyen, P., & Hsu, K. Predictability of Hydrometeorological Extremes and Climate Impacts on Water Resources in Semiarid Zones: Expectations and Reality. **The Bridge National Academy of Engineering**, 50(1), 33-42.

11. Nguyen, P., Ashouri, H., **Ombadi, M.**, Hayatbini, N., Hsu, K. L., & Sorooshian, S. (2020). PERSIANN-CDR for Hydrology and Hydro-climatic Applications. In Satellite Precipitation Measurement (pp. 993-1012). **Springer**, Cham.

12. Salih, A. and **Ombadi, M.** (2017): Sudan and the Water Sciences Programmes of UNESCO, **University of Khartoum Engineering Journal**, 6, 20-24.

Under-review

13. **Ombadi** et al., Complexity of hydrologic basins: A chaotic dynamics perspective.

14. **Ombadi** et al., Multivariate Empirical Dynamical Modelling for Streamflow Forecasting and Its Comparison to Long short-term memory (LSTM) Networks.

15. **Ombadi** et al., How much Information on Precipitation is Contained in Satellite Infrared Imagery?

[You may check this link for any recently accepted articles https://sites.uci.edu/mombadi/cv/]

Career

University of California Irvine, Teaching Assistant (Hydrology CEE 176/276), Fall 2020
University of California Irvine, Teaching Assistant (Hydrology CEE 176/276), Fall 2019
University of California Irvine, Graduate Student Researcher, Fall 2016 - Present
University of Khartoum, Research Assistant, 2015 – 16
University of Khartoum, Teaching Assistant, 2014 – 15

Fellowships & Awards

2020-21 Henry Samueli Endowed Fellowship.
2020 Outstanding Young Engineer Award, Orange County Engineering Council (OCEC).
2016 Swedish Institute Study Scholarship (selected).
2018 National Science Foundation (NSF) Award to attend AMS Policy Colloquium.
2019 United Nations Food and Agriculture Organization (FAO) Award to attend Conference. of Ministry of Water Resources, Sudan.
2020 Associated Graduate Students (AGS) at UCI Travel Grant.

Colloquiums

American Meteorological Society (AMS) Summer Policy Colloquium, 2018
NASA JPL Center for Climate Sciences Summer School, 2017
UNESCO IHP 12th Kovacs Colloquium, 2016

Community

Student Member of American Meteorological Society Commission on the Weather, Water and Climate Enterprise (CWWCE) Steering Committee.
Peer review Geophysical Research Letters, Remote Sensing, Water Resources Research
Graduate Peer Mentor. Mentor for incoming international graduate students at University of California Irvine 2020-21.
Young Scientist Member. Sudanese National Academy of Sciences Standing Committee on Water.

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Talks & Poster Presentations	**2020 American Geophysical Union Fall Meeting: "**Toward an Improved Understanding of Hydrologic Complexity", Oral Presentation. **2020 American Meteorological Society Annual Meeting: "**Causal Inference: A pathway for System Identification using Observational Datasets", Oral Presentation. [video] **2019 American Geophysical Union Fall Meeting:** "A Nonlinear Dynamics Approach to the Analysis of Soil Moisture-Rainfall Feedback", Poster Presentation. **2018 American Geophysical Union Fall Meeting:** "Application of Graphical Models for Causal Detection in Hydrometeorological Systems", Poster Presentation. **2017 American Geophysical Union Fall Meeting:** "Assessment of Developing Intensity Duration Frequency Curves using Satellite Observations", Poster Presentation.
Programming & Software Skills	**MATLAB** (Advanced), **R** (Advanced), **Python** (Intermediate), **ArcGIS** (Advanced)
Professional Membership	American Geophysical Union (**AGU**), American Meteorological Society (**AMS**), American Association for the Advancement of Science (**AAAS**), American Society of Civil Engineers (**ASCE**), Engineers Without Borders, National Society of Black Engineers (**NSBE**).

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DEPARTMENT OF CIVIL & ENVIRONMENTAL ENGINEERING

CENTER FOR HYDROMETEOROLOGY AND REMOTE SENSING (CHRS)   949/824-8825; 949/824-8831 Fax
DR. SOROOSH SOROOSHIAN, DISTINGUISHED PROFESSOR AND DIRECTOR   Email: soroosh@uci.edu
E/4130 ENGINEERING GATEWAY, IRVINE CA 92697-2175 USA   URL: http://www.chrs.web.uci.edu

December 13, 2020

Black Trailblazers in Engineering Program
Purdue University
West Lafayette, IN, 47907

Dear Selection Committee:

It is my great pleasure to give my strongest support for Mr. Mohammed Omer Salah Ombadi's application to the prestigious Black Trailblazers in Engineering (BTE) program at Purdue University. Mohammed is pursuing his Doctoral degree in the University of California, Irvine (UCI) Department of Civil & Environmental Engineering (CEE). He has passed his Ph.D. candidacy exam with flying colors and is expected to complete the Ph.D. program in Spring 2021. He has also been granted U.S. permanent resident status.

In the way of background, on a trip to Sudan for an international meeting back in 2015, I was introduced to Mohammed by one of his professors at Khartoum University. This resulted in my interviewing him on a boat trip arranged by the organizers to see some of the hydro-ecological features of the Nile River where Mohammed was one of the student guides for our group. Within five minutes I was so impressed that I invited him to apply and join my research group. Mr. Ombadi entered the doctoral program in Fall 2016 under my supervision in the CEE Department. His academic performance to date has been stellar as shown by his GPA 3.97 (CEE GPA 4.0). He is showing incredible potential not only intellectually but also in terms of thinking "outside the box" when it comes to research and his leadership capacity. Typically when it comes to writing letters of recommendations for deserving students, the common practice is to describe the students research abilities followed by some discussion their personal characteristics. In my writing this letter for the BTE program, I wish take this opportunity to comment on his leadership potential and his commitment to self-development towards solving practical societal and environmental problems.

Leadership and Civil abilities

Mohammed has shown a high degree of enthusiasm and commitment about making sure that his engineering education and training will be important to address societal concerns about issues such as flooding, water scarcity, etc. For this reason, and my confidence in his abilities, I requested that he represent our center (CHRS) at a UNESCO held meeting in Sudan during 2018 and introduced our datasets to the participants of the workshop on water harvesting. Both UNESCO and the Sudanese Ministry, recognizing his remarkable talent, invited him to participate in a Water Resources Planning and Management workshop hosted by the Ministry of Irrigation and Water Resources, Sudan in December 2019 as a water expert.

Mr. Ombadi has also attended a highly competitive two-week American Meteorological Society (AMS) Summer Policy Colloquium workshop in Washington DC along with a handful of other applicants and became familiar with how science policy and governance are shaped in order to serve society. He was also invited to attend a climate summer school at the NASA Jet Propulsion Laboratory (JPL) Center for Climate Sciences in August 2017, again, a very competitive program to get into.

He is currently active in professional societies such as American Society of Civil Engineers (ASCE), American Geophysical Union (AGU), American Association for the Advancement of Science (AAAS), Engineers Without Borders (EWB) and the American Meteorological Society (AMS). It is noteworthy that Mohammed is the only student member of the AMS Commission on the Weather, Water, and Climate Enterprise (CWWCE) Steering Committee. This is a strong endorsement of Mohammed's leadership potential given that a prestigious organization such as AMS has appointed him to the steering committee.

Research accomplishments and abilities

Mohammed is currently a research assistant on a project funded by the U.S. Department of Energy addressing the impact of the intensification of the hydrologic cycle due to climate change and its impact on the non-stationarities of the extreme precipitation. His research productivity has been remarkable and in a short time he has used a high-resolution (25km daily) satellite rainfall product known as PERSIANN-CDR to develop flood frequency and intensity duration curves for global application. The data set covers the period from 1983 to the present which is over three decades of high-resolution precipitation estimates. His results have been published in top journals, including the prestigious hydrology journal *Water Resources Research* and include 9 articles and one book chapter; 2 of these articles are authored primarily by Mohammed (1st author).

The innovative aspect of Mohammed's research work is his attempt to pioneer the use of causal inference methods for analysis of hydrometeorological systems. These emerging techniques from the fields of computer science, statistics and dynamical systems possess great utility in hydrology due to the rapid increase of in-situ and remotely sensed observations. Mohammed's recent publication in *Water Resources Research* is perhaps the first to comprehensively introduce concepts of causal inference to the field. His remarkable statistical and hydrologic skills combined with the ability to capitalize on satellite observations produced a framework that can now be applied to most regions of the world suffering from lack of ground-based observations of precipitation. With the application of Mohammed's work in California we are now able to have an alternative approach for developing intensity duration curves using remotely-sensed data capturing the observed non-stationary behavior of extreme rainfall which will be critical for both engineering design of infrastructure and operations.

In recognition of his research work, Mr. Ombadi was the recipient of the UCI Civil & Environmental Engineering Dept. 2020/21 Henry Samueli Fellowship Award. Mohammed was also recently named one of recipients of the Orange County Engineering Council (OCEC) 2020 Outstanding Young Engineer award.
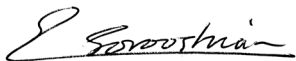
Concluding remarks

It is noteworthy that Mohammed has shown resilience in the face of challenges while still making exceptional achievements. In this regard Mohammed's story and experience of nearly 2 years ago speaks highly of his ability to show resiliency under stressful conditions. Of course I am speaking of the several months of political upheaval in Sudan while every citizen faced extremely difficult conditions, including Mohammed's family. He was able to handle the stress about his parents situation during the revolution that brought down the Sudanese President and continue his classwork as well as his research.

Mohammed has great potential to pursue a successful career in academia. He has exhibited maturity and a sense of civic responsibility by applying his talents and mentoring younger students. Mohammed was the TA in my hydrology course in the Fall of 2019 where he also delivered a few of the lectures to undergraduate and graduate students in my absence. The course evaluations for his performance were exceptional and all 80+ students were unanimous in their praise for Mohammed's ability to communicate with them and show great patience in his interactions.

In respect to his personal characteristics, I find him to be very personable and he has excellent verbal and written communication skills. His relationship with his peers and classmates is excellent and demonstrates his leadership and interpersonal skills.

In closing, I consider Mohammed to be in the top three percent of individuals at a similar stage in their development in terms of intellect, leadership skills, and moral character. I am extremely impressed and pleased with Mohammed's initiatives, work ethics, and overall abilities. I hope my letter will convince the committee Mr. Mohammed Ombadi is an ideal candidate for the BTE program at Purdue University.

Sincerely,

Soroosh Sorooshian, Ph.D., NAE
Distinguished Professor, Departments of Civil & Environmental Engineering and Earth System Science
Director, Center for Hydrometeorology and Remote Sensing, University of California, Irvine, 92697-2175