Machine Learning Algorithm Development for Quality Assurance of Lutz Catchment Run-Off Data

Project Proposal & Statement of Work

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POTENTIAL ADVISORS:
Dr. Sriram Iyengar (*The University of Arizona College of Medicine, Phoenix*),
Steven Paton (*Smithsonian Tropical Research Institute*)

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Version	Summary of Changes	Date
0.1	Converted template to LaTeX, started References and §1	09/13/25
0.2	Began §2, §3; transcribed §4; completed §5	09/16/25
0.3	Continued §3; updated §4	09/18/25

Contents

1 Executive Summary

The algorithms will conduct quality assurance of temporal run-off data from the Lutz Weir of Barro Colorado Island, Panama. This will remove the need for manual data corrections, which not only use the vaLuable time and energy of researchers, but also have the potential to be imprecise or inconsistent. Other variables—such as rainfall and soil moisture measurements—can be integrated to produce a more well-informed model.

The Lutz Weir is located on the northeast slope of Barro Colorado Island, Panama (Figure 1). It has been collecting run-off data since January 1, 1972, with frequency of measurements ranging from three minutes to three hours. Until July 19, 1989, water level was recorded on paper charts, which have since been digitized. Millions of data points are currently present in the set, with more added as the sensor continues to record measurements.

Quality issues in the data come about due to the need for re-calibration, debris blockages resulting in monomodal run-off value increases without rainfall, complications from weir blockages paired with rainfall, false positives, impossible sub-zero values, evapotranspiration, considerations for annual intentional pond drains, and signal noise. Currently, quality assurance is conducted manually via the Visual FoxPro interactive visual interface. Not only does this approach run the risk of imprecise or inconsistent corrections, but the deprecated status of the language and interface leaves it vulnerable. Past attempts at automated quality assurance have failed due to the failure modes' resilience against traditional stochastic methods.

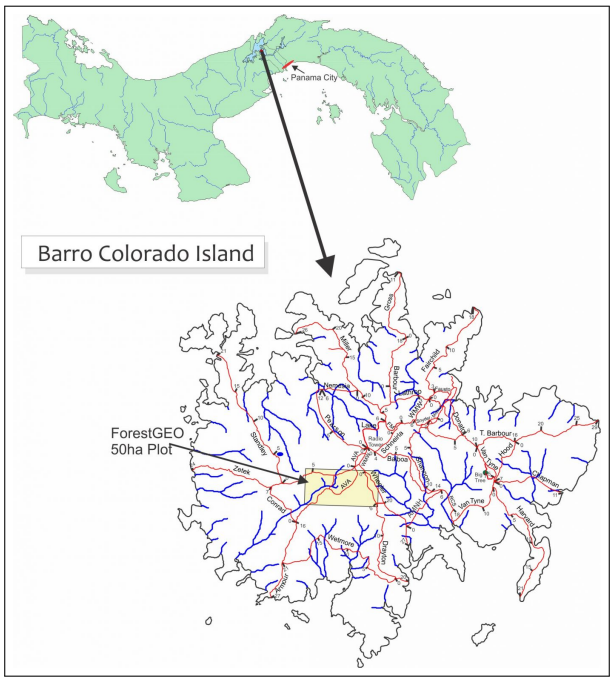

Figure 1: The Clearing ("*El Claro*") on Barro Colorado Island, Panama. [1]

Given that the project is still in its early stages, a literature review will first need to be conducted to identify comparable machine learning approaches for quality assurance of temporal data.

An outline of anticipated project responsibilities is provided in Table 1. Steven Paton—director of the Physical Monitoring Program at the Smithsonian Tropical Research Institute—will be the primary contact regarding background information of the data, knowledge of exceptional data point ranges (such as extenuating circumstances, e.g., a tree fall damaging equipment), and any hydrological questions that come about.

Team Member	Feature responsibility
Gillian McGinnis	Literature review & research
"	Exploratory data analysis (EDA)
"	Failure mode classification model
"	Failure mode correction models
"	Model quality evaluations
"	Reproducibility documentation
"	Course deliverables and presentation preparations
"	User interface (*time permitting*)

Table 1: Preliminary Subsystem Responsibilities

2 User/Market Research

Overall market

The target user for these models will be hydrology researchers analyzing temporal weir and environmental data in parallel. However, given the specificity in location of the weir of interest, it is possible that other factors (such as temperature) may have greater or less influence on run-off data at other weirs around the world and could render final correction models unsuitable for other weirs.

Existing competitors

Visual FoxPro is currently the only software used by Paton to manipulate the data. While the interface is sufficient for completing the tasks at hand, the software is vulnerable due to its depreciation. Furthermore, it is not currently set up to automatically detect problematic portions of the data.

Currently, there is no plan to "market" these tools—rather, emphases on readability, accessibility, and reproducibility will be maintained.

User insights

Because data monitoring is ongoing, new data must be regularly checked for occurrence of any type of failure mode.

3 Product Features

Feature 1. Detection of Periods Containing a Failure Mode

The system will determine where there are readings containing a potential failure mode. This also requires the system to determine the time range in which a failure mode is occurring. A challenge for this feature is that some failures occur in extremely short intervals of time (even as few as one reading), while others can spoil data spanning multiple weeks.

Feature 2. Classification of Failure Mode

Upon a period being flagged as containing a failure mode, it will need to be classified. A brief overview of different failure modes is provided in Table 2.

Failure Mode	Description	Complicating Factors
Calibration	Standard checks that require baseline correction or slight data pivot.	Recovery after blockage clearing can render calibration points ineffective.
Spike	Short and abrupt changes in level typically caused by equipment issues.	Extremely short-term issue that could be skipped over by random sampling.
Sub-zero	The stream runs dry, or the pond is being drained for cleaning.	Rain during a pond draining can render new data unrecoverable.
Signal noise	Equipment failure results in impossible variability of reported values.	Impossible to manually fix.
Blockage	Debris blocks the weir's 'V', resulting in a gentle increase in water level.	Rainfall events before, during, or shortly after a blockage can interrupt the base flow and decay curves.

Table 2: Overview of Weir Failure Modes [2]

Feature 3. Quality Assurance on Periods of Failure

Based on the classification result from Feature 2, additional models will attempt to adjust the raw outputs to the appropriate values had an error not occurred. This will likely involve creation of multiple separate models, as the method in which the data is corrected differs based on the classification of failure type—for example, an interrupted drainage caused by a blockage in the weir can be fixed by the expected decay curve, while a spike is simply flattened.

4 Project Timeline & Gannt Chart

Milestone	Date
Mentor finalization	09/12/25
Signed proposal	09/23/25
EDA	09/29/25
Failure mode multiclass categorization model	10/27/25
Individual failure mode QA models	11/17/25
Model instructional writeup	11/24/25
iShowcase presentation	12/05/25
Final capstone	12/10/25

Table 3: Milestone Schedule

5 Ethics

#	Question	Generally	Data Breach
1	Could a user sell drugs or other illegal items on your platform?	No	No
2	Could a user of your platform engage in sex trafficking?	No	No
3	Could a user sell class notes or cheat on their homework on your platform?	No	No
4	Could a stalker use your project to find someone?	No	No
5	Could your app be used to spy on or track individuals?	No	No
6	Could your app/software access the camera or microphone and record things without users being aware?	No	No
7	If someone uses your platform, could they be re-traumatized or have their mental health impacted in some way?	No	No
8	Could your algorithm promote material that would traumatize or upset individuals?	No	No
9	Would your users be upset if the data you collect was given to someone else?	No	No
10	Could a data leak potentially lead to identity theft?	No	No
11	If your site was hacked, would users of that product potentially lose their job, spouse, or family?	No	No
12	Should there be an age limitation on your product?	No	No
13	Could someone use your product to find, contact, and potentially commit elder abuse?	No	No
14	If the data on your platform was breached, could it be used to blackmail the users?	No	No
15	Does the existence of your project imply that a particular racial group, gender, religion or other protected category is inherently bad, gross, or unwanted?	No	No
16	Could your product be used to commit hate crimes against a specific group?	No	No
17	Does the primary content of your game or algorithm focus on something considered deeply unethical?	No	No
18	Does your game or software contain race, gender, or other stereotypes?	No	No
19	Could users of your app scam other individuals?	No	No
20	Is your particular algorithm biased towards predicting correctly only for one race, gender, or other group?	No	No
21	Are the users of your project, players of your game, or those being surveyed for your data aware of how their data will be used?	No	No
22	What are the possible misinterpretations of your results? For example: would a white supremacist or misogynist be stoked about your results if they misinterpreted it?	No	No
23	Does the use or purchase of your data potentially contribute to a dangerous group or regime?	No	No
24	Could your virtual reality environment cause injury to the user?	No	No
25	Are your study participants or game players aware that their data will be collected and used?	No	No
26	Does your game or app contain addictive design elements without benefit to the user?	No	No
27	Does your survey contain an aspect of compulsion or unusually large incentive, that would command users to take it even if it was to their detriment?	No	No
28	Could your research outcomes harm an individual or entity?	No	No

6 Approvals

The signatures of the people below indicate an understanding of the purpose and content of this document by those signing it. By signing this document, you indicate that you approve of the proposed project outlined in this Statement of Work, the division of work, the Ground Rules and that the next steps may be taken to create a Product Specification and proceed with the project. This document is based upon and supersedes the *<PRD title> Version X.X. Deviations*, (versus clarifications), from the PDR have been clearly noted. For any requirements not listed in this SOW, the PRD requirements shall remain in effect.

Approver Name	Title	Signature	Date
Gillian McGinnis	Project Manager	.	09/23/25
Sriram Iyengar	Advisor	.	
Nitika Sharma	Instructor	.	

	Section	Author	Word Count
1.	Executive Summary	Gillian McGinnis	#
2.	User/Market Research	"	#
3.	Product Features	"	.
4.	Project Timeline	"	.
5.	Ethics	"	N/A

7 Appendix

A. Advisor Engagement

1) Project Team Responsibilities

- The Project Manager will set up and facilitate a weekly call/meeting with the Faculty Advisor. The Project Team will provide weekly status updates to the Faculty Advisor including upcoming deliverables, critical issues, and any adjustments to the Project Plan.
- Documents will be provided to the Faculty Advisor with adequate time for review and signature. The time necessary for review will be agreed with the Advisor. The minimum review time will be 3 days prior to the document due date.
- Design files will be provided to the Faculty Advisor as requested in a format agreed to with the Advisor.
- Support requirements will be clearly requested from the Faculty Advisor with the dates required and an adequate time for fulfilling the request.
- Modifications requests to the Project Plan by Faculty Advisor will be reviewed and agreed to within 1 week of the request.

2) Faculty Advisor Responsibilities

- The Faculty Advisor will provide knowledge and expertise to help the group stretch their skills.
- The Faculty Advisor will participate in a weekly or bi-weekly call/meeting with the Project Team to review the project status, upcoming deliverables, priorities, issues, and progress to the agreed Project Plan.
- The Faculty Advisor will provide document review, feedback and approval, rejection, approval with contingencies with adequate time for the Project Team to meet the course due dates.
- The Faculty Advisor will provide feedback to requested support requirements from the Project Team. This includes feedback and guidance on design implementations decisions, design files, test plans, test procedures and test results.
- The Faculty Advisor shall provide technical advice and guidance to the Project Team answering inquiries approximately 1 hour per week.
- Modifications to the Project Plan by the Project Team will be resolved and documented within 1 week of the request.
- Grade the finalized project using a skill-based rubric
- Attend iShowcase in May.

B. Ground Rules

As a team and as individual team members, we agree to:

1. **Stay focused on our objectives and goals.**
   Each time the team meets, we will clearly define our objectives and desired outcomes at the beginning of the meeting. We will politely remind team members if we are getting off track.

2. **"Sidebar" any issues that are relevant but not consistent with the immediate objectives.**
   Occasionally, important matters are raised that are not relevant to the immediate goals of the meeting. To keep the group on track, but avoid losing the issue, create a "sidebar" where these topics can be listed and discussed later.

3. **Listen when others are speaking.**
   We will listen and consider others' input before adding our own comments.

4. **All viewpoints will have an opportunity to be heard.**
   We understand that some team members may be quieter than others. We will make an effort to get each team member's viewpoint and that no one dominates the discussion.

5. **Differences of opinion will be discussed respectfully.**
   We will identify areas of agreement before assessing areas of disagreement. We will encourage each other to look beyond our own point of view. We will discuss different ideas respectfully. As a team, we will weigh the merits of different opinions and agree on a process for choosing a direction. All team members will respect and follow the decision or direction.

6. **Look for the good points in new ideas.**
   We will endeavor to explore the value in each idea as we assess and select our path forward.

7. **Focus on the future, not the past.**
   We will use our past experience to inform our decisions, but focus the discussion on the future objectives. Blame for past performance is counterproductive, we will focus on finding solutions.

8. **Agree upon specific action items and next steps.**
   At the end of each meeting and discussion, we will summarize and agree on specific next steps, action items and assignments.

9. **Accountability**
   As team members, we will each be responsible for our individual assignments and contribution to achieving the team objectives and goals. We will honor our responsibilities and not let our team members down.

References

(1) Smithsonian Tropical Research Institute Barro Colorado (Clearing, Lutz, Conrad weir), 2025, https://striresearch.si.edu/physical-monitoring/barro-colorado/ (accessed 09/13/2025).

(2) Paton, S. BCI Hydrology Introduction, personal communication.