Final Evaluation Report

Your Details	
Full Name	Thiago B A Couto
Project Title	Cumulative effects of small hydropower dams in rivers of the Brazilian Araucária Moist Forest
Application ID	24182-1
Date of this Report	March 13th, 2022

1. Indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
Investigate the magnitude and extension of the ecological effects of SHPs on fish and Invertebrate communities and habitat characteristics			■	After some adjustments in the sampling design, the spatial inference became more limited than initially planned. However, magnitude and directionality of ecological effects could be estimated. Results for this objective and its conservation implications are currently under review in the scientific journal Freshwater Biology.
Test whether the magnitude and extension of such effects can be predicted by dam attributes (ex: size, proportion of flow Regulated)			■	After some adjustments in the sampling design, the spatial inference became more limited than initially planned. However, magnitude and directionality of ecological effects could be related to several dam attributes. Results for this objective and its conservation implications are currently under review in the scientific journal Freshwater Biology.
Explore whether downstream releases by a series of SHPs modify thermal regimes in rivers and reduce spawning opportunities of valued native fish species whose reproductive strategies depend on summer thermal regimes		■		Prior to fieldwork, a study was published demonstrating the unsuitability of infrared cameras installed in drones to measure water temperature in rivers. After reading it, we opted to adjust our approach to include just in-stream water sensors. This process limited our ability to associate temperature regimes with fish spawning opportunities. However, we were able to estimate direct effects of small hydropower on stream temperature regimes. A total of 28 temperature loggers were placed and recovered across the Basin between the summers of 2018 and 2019. Results for this objective and its conservation implications supported the fourth chapter of my PhD thesis and are being incorporated into a manuscript that will be submitted to Frontiers in Environmental Sciences.

2. Describe the three most important outcomes of your project.

a). Strong empirical evidence of the impacts of small hydropower on freshwater biodiversity and habitats, highlighting the limitations of policies and regulations in place in Brazil. These results lead to two scientific papers (one already in the final stages of peer-review in the journal Freshwater Biology) and one PhD dissertation.

b). Increased awareness and research interests about the socioecological problems associated to small hydropower plants in Chapecó and other parts of southern Brazil. This happened at the local and state levels. After this project taking place in Chapecó, several students and faculty members from local universities are now engaged in their own research projects to investigate the ecological effects of small hydropower (I am currently involved in a few of these initiatives). In 2020, I was invited to give a talk in a public hearing conducted in the Legislative Assembly of the State of Paraná (https://t.co/F2iPbd679g; 2:08:22). The topic discussed was the rapid spread of small hydropower in the state and the need for better regulating small dams.

c). The field experience that I got in this project provided me some important insights to fit a national-level GIS assessment on river fragmentation by hydropower (also part of my PhD research). The field recognition helped to validate the national dataset on hydropower dams and to choose appropriate spatial scales for the analysis. Results from this investigation were published in the journal Nature Sustainability in 2021. https://www.nature.com/articles/s41893-020-00665-4.

d). From my knowledge, this research is the first to demonstrate how different hydropower sizes and operation modes can be used to predict the magnitude and directionality of their effects on freshwater biodiversity. I expect this achievement to produce waves in the freshwater ecology field, and to help the Brazilian agencies to better design policies and regulations on small hydropower licensing. Scientific evidence like this helps to fuel discussions about the sustainability of small hydropower (e.g., the one conducted the Legislative Assembly of the State of Paraná). Our research highlights that the current definition of "small" is quite arbitrary from the ecological perspective.

3. Explain any unforeseen difficulties that arose during the project and how these were tackled.

Logistics and accessibility to field sites posed major challenges to sampling. First, the studied rivers are hard to navigate (due to rapids and waterfalls), and road-infrastructure is quite limited (at least four flat tyres during the expedition). Therefore, we came up with a hybrid scheme that included a truck and an inflatable boat operated with a horizontal shaft motor. This strategy gave us some flexibility, although loading/unloading the truck and launching the boat several times a day was physically exhausting.

Second, we had to access sampling sites through many private lands - most of them owned by forestry companies and ranchers that also own most of the small hydropower plants in the region. This required a lot of patience and communication,

but we were fortunate to get the permits to sample all dams that we attempted to visit (12 in total).

With these two logistic constraints, we were forced to rethink our sampling design to reduce the number of samples per dam and to extend our fieldwork activities in 2018 and 2019. As mentioned in the project achievements table, this new sampling design limited our ability to infer spatial patterns, but it provided sufficient statistical power to address objectives 1 and 2.

4. Describe the involvement of local communities and how they have benefitted from the project.

There was the involvement of students and faculty from the ecology department of the public university Unochapecó. Dr. Renan Rezende led the processing and identification of invertebrates, with several undergraduate and graduate students from his lab being trained during the process. In addition, four students/local biologists composed the fieldwork team as volunteers (Gelso Campos, Anderson Kassner, Yan Soares, Camila Cipriani). They all got trained to conduct fish and limnological surveys. I also gave two 1-hour talks at Unochapecó (2018 and 2020) where I explored the growing threat of small hydropower and presented this project. In the crowd, there were ~25 people in each event, including faculty, students and practitioners that are based in Chapecó (one of the practitioners is directly involved with small hydropower licensing in the region). Several students and faculty members that were in the crowd are now engaged in their own research projects investigating the ecological effects of small hydropower. This indicates that the project was successful in creating awareness about the small hydro issue among local researchers and practitioners.

The project also included the direct and indirect involvement of local fisherman and dam operators that expressed concerns about the rapid spread of small dams in the region. One fisherman (Lauri Lamb) was a critical member of our team during the days we spent in Barra Grande, SC. Besides having experience in navigating in the region, he facilitated our access to three dams (he is a former employee of a paper industry that own these dams). He was hired to work with us during our stay in Barra Grande. Lauri and other fisherman/dam operators are still in touch with me sharing images of new dams being built in their rivers.

5. Are there any plans to continue this work?

For now, my priority is to publish the results of this project in scientific journals and continue supporting discussions on the sustainability of small hydropower (locally and nationally). I work now as a temporary postdoc researcher and there is not much time available to lead a continuation of this project. Although there is no direct continuation in the radar, this project incentivised several new research projects lead by students and faculty members of local universities. They include investigations about the effects of small hydropower on biodiversity and leaf litter decomposition, with funding from the national science agency of Brazil. I am involved in some of these projects as a collaborator and I am co-mentoring a PhD student from Unochapecó (Cristiano Ilha). There was an initial plant to put together

a proposal to Rufford Foundation, but the COVID pandemic added many uncertainties about conducting fieldwork during the past year.

6. How do you plan to share the results of your work with others?

The results of this project are intended to be shared in different formats. At least two scientific papers and one PhD thesis will be published to reach the academic audience. One of the papers is in the final stages of peer-review in the journal Freshwater Biology, and the other one is in preparation for the journal Frontiers in Environmental Sciences. The PhD thesis is already published (https://digital.lib.washington.edu/researchworks/handle/1773/45497).

The results of this research were also part of different talks that I gave targeting students, researchers, practitioners and members of the general public. Two of these talks were at Unochapecó in 2018 and 2020 (~25 people), one at Universidade de Brasília in 2019 (~40 people), one at Florida international University in 2020 (~60 people), and one at the Legislative Assembly of the State of Paraná (streamed live on TV and other state media). After going through peer-review, I am planning to publish reports and white papers targeting a broader audience like this: https://www.nationalgeographicbrasil.com/meio-ambiente/2021/10/pequenas-hidreletricas-na-amazonia-sao-insustentaveis-ineficientes-e-quase-sempre-injustificaveis. Social media posts to advertise the project (Instagram, Twitter) were released during 2018-2020.

7. Looking ahead, what do you feel are the important next steps?

We were able to collect valuable information. My main goal is to continue sharing our findings with multiple audiences. The publication in scientific journals is a very important step to validate our findings with the peers. The management implications of the project will get much more impactful after this step. The first paper is very close to be accepted by a reputable journal (Freshwater Biology).

The pandemic and the current political situation in Brazil made more challenging to work with small hydropower in the region. Fortunately, local researchers are now aware of the issue and have been leading new scientific projects to investigate the ecological effects of small hydropower. I will continue to work in close collaboration with these groups and keep an eye for future opportunities.

8. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did the Foundation receive any publicity during the course of your work?

Yes, Rufford Foundation was acknowledged in all academic talks and presentations that I gave in Chapecó, Brasília, Seattle and Miami, with the Rufford logo being used in all instances. The foundation is also acknowledged in all publications that were released so far (listed below) and in the prospective scientific papers that are under peer-review (not published yet).

Couto, TBA. 2020. Patterns and ecological implications of small hydropower development in Brazil. PhD thesis, University of Washington. https://digital.lib.washington.edu/researchworks/handle/1773/45497

Couto, TBA. 2021. Safeguarding migratory fish via strategic planning of future small hydropower in Brazil. Nature Sustainability. https://www.nature.com/articles/s41893-020-00665-4

9. Provide a full list of all the members of your team and their role in the project.

Dr. Julian D. Olden (University of Washington, WA, USA) – faculty advisor, research planning, sampling design, data analysis, writing.

Renan Rezende (Unochapecó, SC, Brazil) and his grad/undergrad students – invertebrates processing and identification, institutional support, logistic support.

Juliano Oliveira (Former manager of Araucarias National Park, SC, Brazil) – logistic support, assistance with permitting.

Gelso Campos (Associação Amigos do Rio Chapecó, SC, Brazil) – fieldwork assistant (volunteer), logistic support.

Camila Cipriani (Unochapecó, SC, Brazil) – fieldwork assistant (volunteer).

Anderson Kassner (Universidade Regional de Blumenau, SC, Brazil) – fieldwork assistant (volunteer).

Yan Soares (Universidade de Brasilia, DF, Brazil) – fieldwork assistant (volunteer).

Lauri Lamb (local fisherman, SC, Brazil) – fieldwork assistant (hired).

10. Any other comments?

I want to apologise for the very long delay for submitting this report. The end of my PhD and the beginning of my current job were quite stressful (from professional and personal reasons). This period involved wrapping up my PhD requirements (dissertation, papers, defence), the birth of my first child and moving countries twice (everything within the initial months of the Covid pandemic). I am very thankful for the support of The Rufford Foundation, and I will continue promoting all the findings of this research to generate as much 'real-world' changes as possible.