Prospectus

Understanding the link between land use and rainfall in Mekong River Basin
(Technical Topic)

Researching effect of automated officiating on sports culture and outcomes
(STS Topic)

By

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction:

The Mekong River provides incredible value for the economy and food security in multiple Southeast Asian countries and China. In Cambodia, fish harvested from the Mekong River accounts for around 65-75% of the total protein in the population's diet (Dugan et al, 2005). The total value of fisheries in the Lower Mekong Basin is estimated at $1478 million (Dugan et al, 2005). While agriculture and aquaculture are important issues to the population of these countries, hydropower is a fast growing industry that can have sweeping effects across the region. While additional hydropower plants will likely serve as an economic boost for these countries, there are potential unintended side effects due to dam-building in these regions. Dam-building alters the flows of river, which can promote the invasion of non-native species, leading to a reduction in biodiversity (Sabo et al, 2017). These changes can have effects on regions such as the Vietnamese Mekong River Delta, where 80% of the population relies on rice cultivation for their livelihood (Wassmann et al, 2019). For the population of the region that relies on fishing for food security as well as financial reasons, a model of the Dai fishery in Cambodia estimated that a 1 meter drop in water flow leads to a loss of around 2,500 tons in total catches (Dugan et al, 2005). This emphasizes the importance that river flows can have on the food security in the region, where fish is a large portion of the population's dietary intake.

Due to the large economic value that the Mekong River provides in this region, studying the effects that increased hydropower usage can have will be important to maintain the agricultural and aquacultural benefits the river provides. While the economic value of the river will be an important part of this research, there are large portions of the population in this region that are subsistence fishers or farmers. In 2009 it was estimated that around 5 million people in Yunnan, a province in southwestern China, relied on agriculture to feed themselves and their

families (Molle et al, 2009). For these previously listed reasons it will be important to further analyze the effect of dam-building on the economy of the region. The technical topic of this Capstone focuses on analyzing agricultural, aquacultural, and hydropower data that is available in order to figure out how to optimally implement and maintain hydropower plants in the Mekong River region.

Technical Topic:

Hydropower is currently the leading source of renewable energy worldwide (Sabo et al, 2017). By implementing hydropower without prior research, the Mekong River could become less productive for agricultural and aquacultural use due to changes in flow. Due to increased participation by Chinese corporations who do not have a stake in the livelihood of the lower Mekong population, there likely has not been significant research done on how to properly implement hydropower in the region. Chinese companies have used their power and resources to influence lower Mekong countries in order to sponsor their dam-building. In Laos, about half of dams built and operated are associated with Chinese companies (Beech, 2019). An assessment by the Mekong River Commission estimated that the economies of the lower Mekong countries will lose around $7 billion if the currently planned hydropower projects are constructed (Beech, 2019). In 2009 there were six hydropower project in operation and six under construction in Laos (Molle et al, 2009). In 2017, the Laos News Agency reported that there were 46 running hydropower plants with 54 more planned or under construction (Phomnuny, 2017). This huge leap in hydropower production in the region provides important economic value through the export of electricity, but also adversely affects food security in the Lower Mekong region. Dam operations in the Sesan River, a major tributary of the Mekong River through central Vietnam and Cambodia, have led to a decline in fish population which directly impacts the livelihood of

the population in this region (Piman et al, 2013). Currently, there are few detailed studies on the effects of recent dam development due to the rapid pace that hydropower plants are being built, which leads to improperly placed hydropower plants. According to interviews of the local population in Cambodia, after the construction of the Ialy Reservoir, fishery yield dropped to around 10-30% of previous year's yields (Groner, 2006). This is an example of how an improperly implemented hydropower plant can negatively affect the local population. Due to the lack of a current technological solution, there is dire need for a better method.

While the decline of fish populations and diversity in the Mekong region is well documented, there are steps that can be taken in order to reduce the impact of future dam-building on the economy and food security in these regions. It would be incredibly difficult to attempt to remove dams in these regions in order to reverse the consequences on agriculture and aquaculture. In order to minimize the impact of future hydropower implementation, there needs to be proper statistical analysis in order to negate the adverse effects. In a data driven approach, researches estimated that by properly implementing hydropower plants, they could potentially exceed pre-dam fishery yields by a factor of 3.7 (Sabo et al, 2017). While this may be overly optimistic due to the impact of past hydropower implementation, it provides hope that there is a way to optimally implement plants in the Lower Mekong Region. There are large data sets online that track the agriculture and aquaculture yields across the world. By implementing these data sets into statistical models and accounting for the effects that climate change and previous hydropower implementation has on food security, the capstone team can begin to formulate a plan to properly coordinate future dam-building.

The previously proposed statistical model and data analysis can help to alleviate the problem by providing an outline for implementing hydropower plants that are currently still in

the planning phase. While there is no way to stop the inevitable boom of hydropower in the region, evidence based decision making can serve to strategically place dams in order to lessen the negative consequences on flow rates in the Lower Mekong Basin. The location of dams as well as their size are important factors in assessing the changes in flow rate that the river will experience (Piman et al, 2013). It is important to correctly assess how a change in a dam's size and location will affect the flow rates of surrounding regions. Due to the impact that fisheries have on countries such as Cambodia, it is necessary to come up with an improved method for assessing when and how to properly construct hydropower plants. The proposed technological solution will utilize Python analysis done on aggregated agricultural and fishery data from software such as Google Earth Engine. By looking at the agricultural and aquacultural data before and after hydropower plants are built in specific regions, trends that negatively affect the region can be found and future hydropower implementations can avoid these pitfalls.

STS Topic:

While the technical portion of this prospectus was focused on the economics of hydropower implementation in the Mekong River region, the STS topic will focus on the causes and outcomes from implementation of automated officiating in professional sports leagues. Automation taking over various jobs is becoming an increasingly discussed topic that has large societal implications. Professor Mike Innes and Dr. Ben Morrison (2017) discuss the movement with concern for lower skilled jobs up to highly-skilled professions being replaced by automated machines. Sports officiating in particular is an interesting example of these implications. Frey and Osborne (2013) ranked jobs in order of the probability that they will be replaced in the coming years by automation, and gave umpires, referees, and other sports officials a 98%

likelihood of being replaced. This move to automation will have implications on the culture of the sport and affect fans, players and managers, to name a few.

This discussion of the connections between the human, social, and technical elements of automated officiating will utilize the Social Construction of Technology framework. This framework argues that development of technology is driven largely by the social groups rather than technological determinism (Pinch and Bijker, 1984). Due to the fact that professional sports are watched largely for entertainment purposes, introduction of automated officiating will succeed if the various stakeholders make concessions and compromises for the betterment of the sport. The use of the Social Construction of Technology framework follows this closely in that groups such as sports players and referees are tied to the sport economically and emotionally and have direct say in the implementation and production of these technologies. Located below in Figure 1 is an illustration showing the connection between the various social groups: players, teams, officials, etc that connect to the artifacts, which are the various technologies related to

automated officiating.

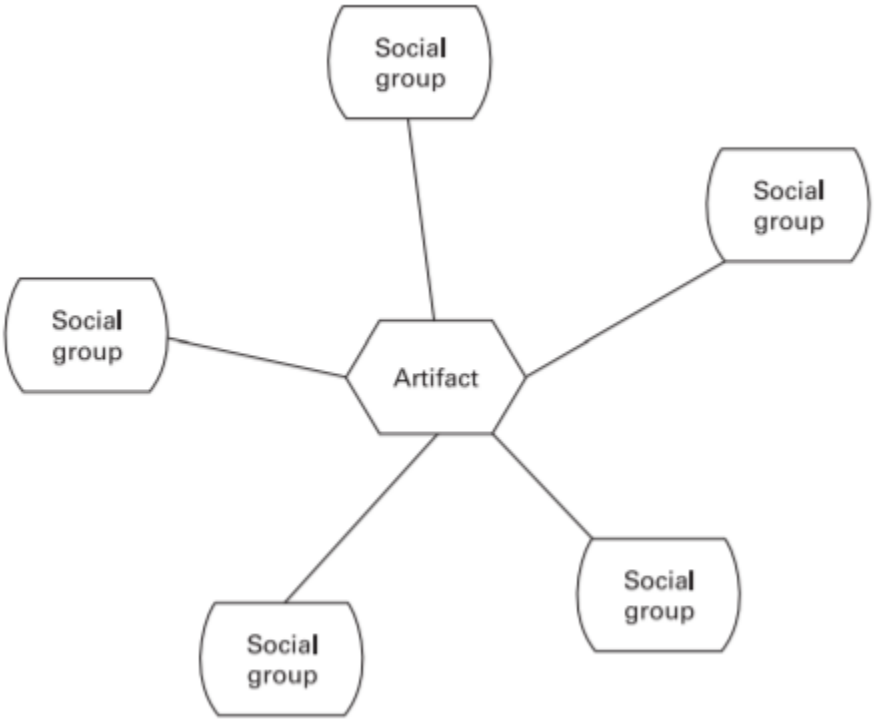

Figure 1: The relationship between an artifact and the various social groups (Pinch and Bijker, 1984)

Through a specific example we can begin to show how direct impact from stakeholders can direct the implementation of automated officiating. At the end of the 2019 NFL season the New Orleans Saints were strongly positioned to win the NFC and compete in the Super Bowl. During the NFC championship however, a pass interference call was missed late in the game that would have short term effects for the Saints, who were bumped out of the playoffs, as well as long term effects that would change how the NFL was officiated. The next season the NFL instituted a new rule that allows pass interference calls as well as a lack of calls to be reviewed via replay. This event is an important example for escalation in automation because it is the first time that judgment calls can be reviewed in the NFL (Kilgore, 2019).

In an article discussing how social factors directly impact the implementation of automation Lin and Chen (2000) argue that automation is most effectively implemented when it is done with support from employees, a competent project leader, and a proper alignment between technical and social factors. They base their argument by collecting data through questionnaires of 105 companies and supplementary interviews of six manufacturing firms in Taiwan. In professional sports leagues players, officials, and sports leagues are tied directly together through the economic success of a sports league. It is imperative for there to be some level of support from each of these stakeholders in order to effectively implement automated officiating. Through press conferences, professional athletes and coaches have a direct line of communication to fans watching, and this can either be used to share supportive or negative opinions regarding new technological implementations.

Various technologies already exist, however, that could improve the accuracy of calls by sports officials. In July of 2019 a computer was used to call balls and strikes in the Atlantic League. The balls and strikes were still verbally called by the umpire, who wore an ear piece connected to the automated system (Bogage, 2019). Even though this has been implemented relatively successfully, there are still arguments that push back against the technology from players and fans alike. For catchers in baseball, great emphasis has been placed on their ability to frame the ball, which means to make a ball appear as if it was a strike to an umpire, and some could argue that an automated strike zone would make this a lost art. Another argument against the implementation of the automatic strike zone is that it would reduce the human interaction during the game. In an article discussing the implications of an automatic strike zone, Jacob Bogage of the Washington Post (2019) discusses the in game communication between coaches, catchers, batters, and the home plate umpire. He uses the Atlantic League as a case study in how

the implemented automatic strike zone appears to limit some aspects of the human element of a baseball game. While it does not appear that the automatic strike zone will be implemented soon in baseball, as pressure from fans increases against umpires, the league will be forced to make a change.

Research questions and methods:

The research question for the technical topic is as follows: how might different placements and structures of hydropower plants in the Mekong River region reduce the agricultural, aquacultural, and economic consequences? One of the main primary sources for the technical portion will be counts of events for hydropower implementation in the Mekong River region. By looking at agricultural, aquacultural, and economic data before and after hydropower implementation the capstone team will be able to quantify the impact. If it were possible to reach out to various stakeholders in the region, it would be beneficial to begin to develop an outline of the societal impact as well. One such stakeholder that would have valuable data would be rural inhabitants of the Mekong River region. The data may be anecdotal but it could help to delineate the negative consequences felt by inhabitants of the region who rely on the yields of the Mekong River. Data related to societal impact will be important to the capstone project because often the implementation of hydropower will be an economic rather than culturally conscious decision. The analysis will be primarily done through geographic analysis, case comparisons, and detailing criteria to measure the impact of planned hydropower plants. Large data sets are online that detail agricultural and aquacultural data around the world. These data sets can be analyzed by using software such as Python, in order to begin sifting through the data and creating a model to predict impact from hydropower plants. This question is important because of the direct impact that hydropower implementation has on the population of the region.

The research question for the STS topic is as follows: how might the introduction of automated sports officiating change the culture and outcomes of sports games? One of the main primary sources for the STS portion will be surveys of sports fans about their feelings regarding automated officiating in sports. The survey would be created using questions that would gather data about their emotional connection to sports outcomes and if they feel that automated officiating is the optimal way to reduce error in officiating. Surveys could be sent out to people in the University of Virginia community or to various sports forums. Case studies can be analyzed in how automation has been properly implemented in other industries. By collecting and analyzing this data, decisions can be made about the likelihood of implementation in the near future. If fans are not behind the implementation of automation it will be difficult for the league to justify this decision. Case studies can also be done by showing that intense fan and team backlash can lead to increased automation in sports officiating. This research question is important because of the large economic and emotional ties between professional sports leagues and their stakeholders.

Conclusion:

The technical deliverable for the Mekong River capstone project will be a statistical model built using publicly accessible data sets that can predict the agricultural, aquacultural, and economic impact of dam-building in the Mekong River region. This model will seek to take in various aspects such as location, size of dam, surrounding agriculture, and ecology of region in order to responsibly implement hydropower in the region. This deliverable will help to alleviate the problems felt in the region by reducing the negative impact that future hydropower plants will have on the economy and food security in the region. Predicting the impact of dam-building in specific locations will allow for continued hydropower implementation without disrupting the

inhabitants of the region that rely on the river for their livelihoods. By accounting for the societal impact that hydropower implementation has on the region, the deliverable will seek to change the culture of disruption that characterizes previous hydropower implantation in the region.

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