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Enriching college students through study abroad: a case of Nepal Field Experience Part 1

Hali Corwin[1], Katie Eddings[1], George Bailey[1], Andrew Braun[2], Aubrey Mann[1], Victoria Gomez[1], Holly Heafner[2], William Faulk[1], Luke Immel[2], Allison Hingdon[1], Brandon Stelly[1], Brittany N. Broussard[2], Layken Willis[1], Timothy C. Martin[2], Thomas J. Mizelle[2], Avery J. Baker[3], Timothy Duex[4], Durga D. Poudel[4*1]

[1]Environmental Science Program, School of Geosciences, University of Louisiana at Lafayette, Louisiana, USA

[2]Geology Program, School of Geosciences, University of Louisiana at Lafayette, Louisiana, USA

[3]The University of Arizona, Tucson, Arizona, USA

[4]School of Geosciences, University of Louisiana at Lafayette, Louisiana, USA

Abstract— **With a view of providing an unsurpassed opportunity to college students, who are mostly from Louisiana, in gaining a comprehensive understanding of Global Climate Change issues, we completed the first Nepal Field Experience Pilot Study Abroad from May 21-June 8, 2019. A total of fifteen students from the University of Louisiana at Lafayette, Louisiana, USA, and one graduate student from University of Arizona, Arizona, USA, participated in the program. Students examined and documented the effects of climate change impacts on agriculture, water resources, wildlife, local communities, forest resources, and other ecological and environmental settings of the country. They identified various climate change mitigation and adaptation measures that had been implemented and noted gaps between policy measures and ground realities. Research topics selected by the students included the following: climate change impacts on wildlife, water pollution, structural geology of Nepal, changing rainfall patterns and adaptation, climate change and agricultural production, geology of Kathmandu valley, air quality of Kathmandu valley, changing hydrology of glaciated landscape, climate change and geohazards, emerging diseases and pests on agricultural crops, climate change adaptation by local communities, green infrastructure and climate-smart technologies, climate change impact on drinking water sources, the roadside geology, and emerging diseases, parasites and zoonotics. Each student completed their individual research project, synthesized the results, and presented to local stakeholders in conference organized by a nonprofit nongovernmental organization, Asta-Ja Rsearch and Development Center (Asta-Ja RDC), Kathmandu, Nepal. Findings of the study reveal that Nepal is experiencing huge impacts of climate change in multiple fronts including atmospheric conditions and snowfall, temperature rise, occurrence of droughts and flooding, changes on monsoon pattern, emerging diseases and pests on crops and livestock, and declining drinking water sources. Environmental pollution, especially the air and water pollution and waste management, was very serious affecting public health, aesthetics, and even the tourism of the country. In order to reverse environmental degradation and enhance climate change adaptation, immediate implementation of effective, comprehensive, coordinated, and well-thought-out climate change adaptation and environmental initiatives are necessary. Nepal Field Experience was a lifetime learning experience for the students.**

Index Terms— Study Abroad, Global Climate Change, Environmental Quality, Geology, Nepal

I. INTRODUCTION

The University of Louisiana at Lafayette has one of the state's best study abroad programs for the past 30 years. The study abroad program allows students to travel to new countries and get immersed in new cultures and tradition. Students are able to further their education and earn credit hours towards their degree. The study abroad program at UL Lafayette offers programs in five different counties; Costa Rica, England, France, Italy, and their newest program, Nepal. Costa Rica is an ideal destination for exploring social and environmental business practices. It is a ten-day program; the first seven days are spent traveling the Central Valley and the Caribbean side of the country while the remainder of the trip is spent at Tamarindo Divia on the Pacific Coast. Study abroad in England is a three-week program that offers students the opportunity to study in one of the most exciting and cosmopolitan cities in the world.

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Corresponding author's e-mail: ddpoudel@louisiana.edu

The study abroad programs offered in France and Italy both have a six-week duration. While students are generally in large groups during the week studying their course work, they have the opportunity to take excursions to neighboring countries on the weekends. The Nepal study abroad program is unlike any of the others offered. Students had the opportunity to spend two weeks in the field in Nepal gaining first-hand and comprehensive understanding of Global Climate Change impacts on a high-altitude environment. There is no better way to take charge of your own education than through travel.

Effects of Global Climate Change on agriculture, ecosystems, and the environment are widespread from coastal areas to high elevation regions. Commonly cited climate change impacts in coastal regions include sea level rise, increased ocean water temperatures, inclement weather conditions, frequent incidences of intense rain events and flooding, and prolonged drought conditions. Similarly, high-altitude regions also currently experience a multitude of climate change impacts including rising temperatures, early snowmelt, incidences of new diseases and pests on crops, erratic rain events, mass wasting, and drying springs. Climate change has been documented to have extremely varied and lasting effects on ecosystems around the world (Bhandari 2018, 2019; IPCC 2007, 2010; Mccright and Dunlap 2003), especially with regard to the hydrologic cycle. It has been associated with changes in precipitation patterns, its intensity and extremes, soil moisture and runoff, and snow and ice melting, which increases evaporation and atmospheric water vapor. One of the biggest way climate change is expressed is through changes in freshwater availability (Agarwal et al., 2014). The changes are anticipated to affect not only average availability of water but also extreme events like droughts and floods. Depending on the developmental stages of countries and available resources to combat climate change impacts, societies across the latitudes are adapting to climate change impacts in many different ways, often the resource-limited societies embracing adaptation measures in a very limited scale or adopting practices without adequate scientific validation processes.

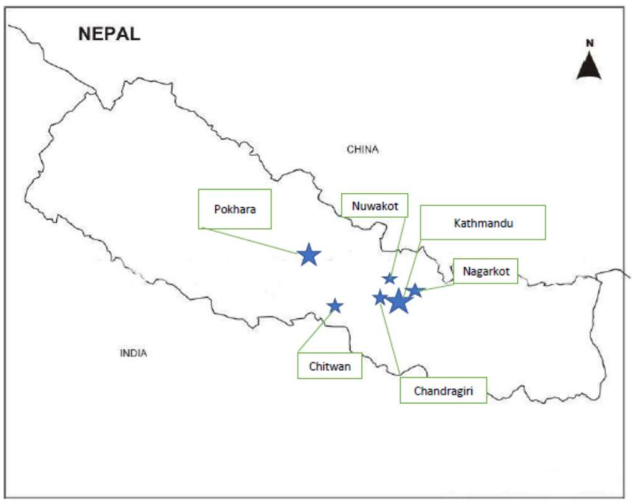
In order to develop a comprehensive understanding of Global Climate Change impacts on agriculture, ecosystems, and the environment across the latitudes, it is critical for students, faculty, and researchers in the discipline of Environmental Science to get field exposures and gain first-hand knowledge in various aspects of climate change, including impacts, exposures, and adaptation. The Environmental Science Program in the School of Geoscience at the University of Louisiana at Lafayette organized a Study Abroad Internship program in Summer 2019 (May 21 – June 8, 2019) in which a group of undergraduate and graduate students spent two weeks in the field in Nepal and became heavily engaged in first-hand and comprehensive understanding of Global Climate Change impacts on high altitude environments. Nepal's elevation ranges from less than 200 m asl (above sea level) to 8,848 m asl at the peak of Mt. Everest. This program provided an unsurpassed opportunity to students, who are mostly from Louisiana, in gaining a comprehensive understanding of Global Climate Change issues. This will put students in a very favorable position in their future Global Climate Change mitigation and adaptation pursuits.

II. Field Activities

Figure 1 shows major places visited during this Study Abroad Program in Nepal. In these places, students visited several institutions, hill summits, tourist destinations, watersheds, national parks, valleys, and villages (Table 1) and learned about climate change impact adaptation activities in Nepal. On May 24, 2019, students visited USAID, Tribhuvan University and ICIMOD and learned about current state of global climate change impacts, adaptation, and environmental education in Nepal. On May 25, 2019, students visited Chandragiri summit, located at 8,333 ft above sea level, while exploring the geology and geomorphology of Kathmandu Valley and its surroundings. Chandragiri, connected by cable car, is one of the main tourist spots in Nepal. It is located south-west of Kathmandu valley. Students had breathtaking panoramic views of the beautiful mountains of the majestic Himalayan ranges and the Kathmandu valley.

On May 26, 2019, students visited the Trishuli river in Nuwakot where a local man was interviewed, saying in his 70 years visiting the river, he has witnessed the water become much browner over the years. The high turbidity was due to increased sediment in the river water. The river had increased flow due to primarily snow melt in the Himalayas. It should also be noted that a construction or excavation site was upstream, and that extremely turbid water was flowing away from the bank directly in this vicinity.

Figure 1. Places visited in Nepal during the Study Abroad Program, May 21-June 8, 2019.



Source: taken by the co-authors of this article

On May 28, 2019, the group visited Nagarkot and observed the geological formation of the mountain ranges. Students interviewed several locals and the hotel manager at Hotel Country Villa in Nagarkot on Global Climate Change impacts on hotel business and tourism. Nagarkot, located to the east of Kathmandu and at an elevation of 7,201 ft above sea level, is a

popular tourist spot in Nepal. The city of Nagarkot has an amazing view of the Himalayan mountains. On a clear day, you can see Mount Everest as well as many other Himalayan peaks from that area.

TABLE 1. STUDENT FIELD ACTIVITIES IN NEPAL (MAY 23 TO JUNE 7, 2019)

Day	Activities
Thursday, May 23	Arrived Kathmandu, checked in Shaligram Hotel
Friday, May 24	United States Agency for International Development (USAID, Tribhuvan University, and International Center for Integrated Mountain Development (ICIMOD)
Saturday, May 25	Chandragiri summit (8,333 m asl) (cable car ride)
Sunday, May 26	Thulokhola watershed, Nuwakot
Monday, May 27	Stayed in the hotel (Shaligram Hotel) due to national strike
Tuesday, May 28	Nagarkot, Bhaktapur
Wednesday, May 29	Road trip to Sauraha, Chitwan; field interviews
Thursday, May 30	Four hour Jeep-Safari of Chitwan National Park and a road trip to Pokhara, Vyas Municipality, Tanahu
Friday, May 31	Sarangkot for sunrise, Fewa Lake, Devi's Falls, Mahadev Cave, Seti Gorge, and Bhim Kali Boulder
Saturday, June 1	Drove back to Kathmandu
Sunday, June 2	Dhobi Khola Watershed, Kathmandu (site 3 and site 4)
Monday, June 3	Kathmandu University, Nepal Agriculture Research Council (NARC)
Tuesday, June 4	Dhobi Khola Watershed, Kathmandu (site 1 and site 2)
Wednesday, June 5	Asta-Ja Research and Development Center (Asta-Ja RDC)
Thursday, June 6	Seminar presentation
Friday, June 7	Return to the USA

Source: prepared by the co-authors of this article

On May 29 and 30, 2019, the group visited Chitwan National Park, a UNESCO World Heritage Site, and went on a four-hour Jeep safari through the park. The park has a total of 68 species of mammals, 544 species of birds, 56 species of herpetofauna, and 126 species of fish. Chitwan National Park is famous for its protection of the Indian rhinoceros, the Royal Bengal tiger, and the gharial crocodile. Established in 1973, it was the first national park in Nepal.

In Pokhara, which is located at an average elevation of 4,600 ft asl and the second largest and most beautiful tourist city in the western region of Nepal, students studied a cave and a waterfall and learned that caves are formed by the dissolution of the limestone. The process starts with rainwater picking up carbon dioxide from the air and as it percolates through the soil, it turns into weak acid. This weak acid then slowly starts dissolving the limestone along the joints, bedding planes, and fractures. Devi's Falls in Pokhara (Photo 1) is famous waterfall in which water rushes through the rocks and carves the unique formation that is seen today. The stream that feeds the falls traverses a tunnel before it becomes a waterfall. The geologic formation at this site was particularly interesting because the water flows through a channel before disappearing into an underground cave. The channel was formed over time due to erosional forces from the running water. Students also studied river channels and glacio-fluvial deposited boulders in a glaciated landscape.

PHOTO 1. DEVI'S FALLS IN POKHARA, NEPAL

Source: taken by the co-authors of this article

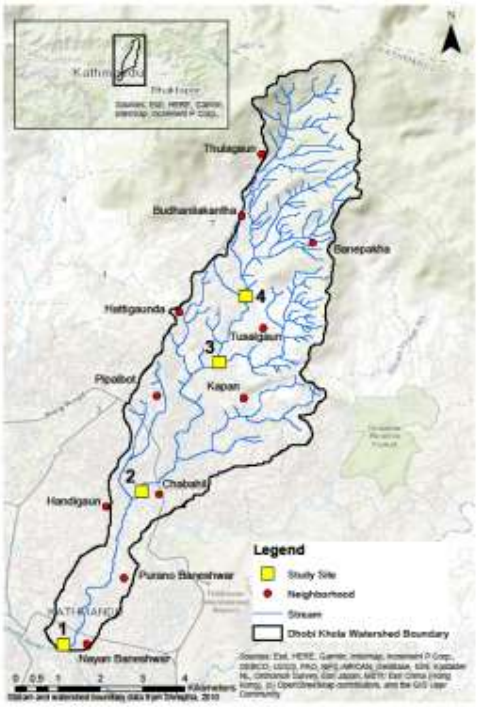
In order to develop a detailed environmental understanding of air and water pollution, solid waste disposal, flood control, stream management, and the development of green-infrastructure, students selected Dhobi Khola watershed in the city of Kathmandu (Figure 2) for a detailed study and spent two days (June 2 and 4, 2019) studying the Dhobi Khola watershed, where four sites were selected for detailed investigation. From furthest downstream (site 1) to progressively farther upstream (sites 2, 3, 4) site 1 was immediately upstream of the confluence of the Dhobi Khola and the Bagmati river, site 2 was at Bhatkeko Pul, site 3 was at the confluence of the Dhobi Khola and the Chilaune Khola, and the site 4 was at the Bhangal by the Mahadevsthan.

On June 6, 2019, students presented their findings to local stakeholders in a conference entitled "Climate Change and Environmental Quality: Challenges and Opportunities" which was hosted by Asta-Ja RDC in Kathmandu (Photo 2).

The sixteen students were divided into six groups with corresponding presentation topics: 1) Geology of Kathmandu and Nepal, 2) Air and Water Pollution of Kathmandu Valley, 3) Climate Change Adaptation and Green Infrastructures, 4) Climate Change Impacts on Rainfall Pattern, Agricultural Production, and Wildlife, 5) Climate Change and Geohazards, and Changing Hydrology of Glaciated Landscapes, and 6) Emerging Diseases, Pests, Parasites and Zoonotics.

On the road trips, students stopped by several road-cuts, stream banks, and rock outcrops for field investigation of lithology, mineralogy, and environmental parameters (Photo 3).

FIGURE 2. STUDY SITES IN THE DHOBI KHOLA WATERSHED OF KATHMANDU, NEPAL



Source: taken by the co-authors of this article

PHOTO 2. STUDENTS PRESENTING THEIR FINDINGS IN A CONFERENCE ORGANIZED BY ASTA-JA RDC, KATHMANDU, NEPAL

Source: taken by the co-authors of this article

Students examined and documented the effects of climate change on agriculture, water resources, wildlife, local communities, forest resources, and other ecological and environmental settings of the region. They identified various climate change mitigation and adaptation measures implemented and the gaps between policy measures and ground realities.

Students were required to keep a well-documented field journal of observations made during the two-week period in Nepal, which helped in compiling the findings at a later stage. Students reviewed relevant research papers and publications in relation to their respective research topics, analyzed geological and meteorological data, and interviewed experts in the field.

PHOTO 3. STUDENTS INVESTIGATING LITHOLOGY, MINERALOGY AND ENVIRONMENTAL PARAMETERS ON THEIR ROAD TRIPS.

Source: taken by the co-authors of this article

Students were required to collect field notes, observations, and information from individual and groups in the communities.

Along with the research and field experience on their respective topics, students visited several temples, palaces, religious shrines, and tourist sites. They ate at many ethnic restaurants and saw a variety of street art. In addition to the academic field experience, students were exposed to Nepalese culture, tradition, food, society, and pagoda architectural style. Students were heavily engaged with the local communities in Nepal to gain an understanding of the climate change impacts from their point of view.

This paper presents the collective information gathered from the group for field visits and literature reviews. The subsequent sections discuss on findings that relate to general geological, hydrological, ecological, environmental, and cultural settings of Nepal, followed by general findings on global climate change impacts, adaptation, recommendation for future study abroad programs on environmental science, and summary and conclusions.

III. GEOLOGICAL SETTING

One hundred twenty five million years ago (Ma) during the Cretaceous period, the Indian plate rifted apart from Antarctica and began moving north until colliding with the Eurasian plate in the Eocene period around 40-50 Ma (Gibbons et al., 2013). The continent-continent convergent boundary resulted in the collision of the Indian plate with the Eurasian plate and the onset of the Himalayan orogeny, which continues to grow to this day. Five major fault zones are recognized as a result of this ongoing collision (Upreti, 1999). A much more complex network of smaller faults exists that were formed to relieve the immense pressure associated with Indo-Eurasian plate boundary (Martin et al., 2010). Thus, geologically, Nepal is located in an active tectonic setting where two lithospheric plates collide. Nepal is divided into five zones, each of which are separated from one another by thrust faults (Arita et al., 1982). These five zones from south to north are the Indo-

Gangetic Plain (also called the Terai), the Siwaliks, the Lesser Himalaya, the Higher Himalaya and the Tibetan Tethys Zone (Upreti, 1999).

The most striking thing about Kathmandu Valley is how flat it is as compared to the surrounding mountains (Photo 4). This is not by accident. Since the late Pliocene, approximately 2.5 million years ago, the area of Kathmandu Valley was covered by a lake, aptly named Paleo-Kathmandu Lake (Sakai et al., 2006). Before the lake formed, the paleo-Bagmati River flowed south across the mountains toward the Siwaliks and the Terai (Sakai et al., 2006). The formation of Kathmandu Valley and the Paleo-Kathmandu Lake basically began with the rising of the Mahabharat range south of Kathmandu (Shrestha et al., 1999). This led to the damming up of the Bagmati River, which led to the buildup of water in the area (Sakai et al., 2006). Once the Chobhar range in the southern part of Kathmandu was formed, the water was ponded in a lake (Sakai et al., 2006). On the southwest border of the Kathmandu Valley lies the Chandragiri Range, which has a steep slope with an abrupt rise from 1,600 m asl to 2,200-2,500 m asl (Saijo and Kiyoshi, 1991). This leaves the area very vulnerable to landslides (Saijo, 1991).

Pokhara Valley is unique in relation to the adjacent landscape. The valley is filled by sediments of three Quaternary age rock units: the Tallakot Formation, the Ghachok Formation, and the Pokhara Formation (Schwanghart et al., 2016a). The Tallakot and the Ghachok Formations are marked by the presence of calcareous conglomerates with a silty matrix; the Tallakot Formation has significantly larger clasts (granule to boulder in size) than its Ghachok counterpart (Schwanghart et al., 2016a). The Pokhara Formation has been interpreted as an alluvial fan deposit, with its head beginning in the northern part of the city along the Seti River (Stolle et al., 2017). The formation also contains a mixture of coarse gravel sheets, boulders, and debris flow deposits (Stolle et al., 2017). It has been hypothesized that Pokhara Valley, like Kathmandu Valley, was the site of a lake in recent geologic history (Stolle et al., 2017). Unlike Kathmandu Valley, which is underlined with sands and muds, Pokhara Valley is covered in gravels (Fort, 2009).

The formation of these gravels in Pokhara Valley is a tale of catastrophe. During the Last Glacial Period, glaciers expanded to fill in the valleys on Annapurna and other nearby mountain ranges of the High Himalayas (Fort, 2009). As the glaciers advanced, they scraped along the edges of the valleys, scooping and pushing debris down the mountain in a large pile known as a moraine (Fort, 2009). At a certain point, the glaciers did not advance any further and the debris was left behind as a terminal moraine.

The melting glaciers left behind a pool of water dammed by the moraine (Schwanghart et al., 2016a). As the Pokhara region is a tectonically active zone, a massive earthquake occurred at some point, loosening the structure of the moraine (Schwanghart et al., 2016a).

PHOTO 4. A VIEW OF KATHMANDU VALLEY FROM CHANDRAGIRI.

Source: taken by the co-authors of this article

Due to this weakness in the dam, the pressure asserted by the melted glacier broke through the dam, releasing a torrent of water into the valley instantaneously (Schwanghart et al., 2016a). This pushed glacial debris, including massive boulders, deep into the valley, lining the basin with an unsorted mix of cobbles, gravels, and sands (Fort, 2009). These debris flows likely blocked the flow of tributaries to the Seti River in Pokhara Valley, creating the lakes seen today (Stolle et al., 2017). The age for the deposition of the Pokhara Formation has been correlated with the 1255 AD earthquake in the region, indicating that these rocks are less than 1000 years old (Schwanghart et al., 2016a). Recent earthquakes, such as the ones in 2015, have created smaller debris flows in the northern parts of the valley, suggesting that continual tectonic activity in the area induces landslides and avalanches that continue to deposit material similar to the Pokhara Formation (Schwanghart et al., 2016).

Catastrophic deposits can be easily seen throughout Pokhara Valley. Continuing straight along Phewa Marga to the shores of Phewa Lake gives access to the gravel deposits that retain the lake (Fort, 2009). Although the waterfront has been modified anthropogenically to further dam the lake, the underlying natural rocks kept the lake from draining for almost a millennium (Fort, 2009). On the north side of town, along Nadipur Road, is Prithvi Narayan Campus. The most prominent feature on the campus is the giant boulder, Bhim Kali (Photo 5). Bhim Kali was moved from the Annapurnas to its present location as a result of a massive glacial flood and debris flow that formed the Pokhara Formation (Fort, 2009). Continuing north along the banks of the Seti River, the river becomes significantly incised and forms a deep gorge. At the confluence of the Seti River and Edi Khola, sediments of the Pokhara Formation and overlying Ghachok Formation are easily visible (Schwanghart et al., 2016). Due to the entrenched nature of the river, debris flows from the Annapurnas are tightly constrained and channeled downstream toward the center of Pokhara Valley, where they can deposit thicker sediments in a wider area (Schwanghart et al., 2016; Fort, 2009).

PHOTO 5. BHIM KALI BOULDER IN PRITHVI NARAYAN CAMPUS, POKHARA

Source: taken by the co-authors of this article

Also known as "rivers of ice," glaciers contain almost all of Earth's freshwater. They are also a common source for rivers, which feed agriculture. According to Bajracharya et al. (2015), with an estimated ice reserve of 6,127 km^3, there are a total of 54,252 glaciers in the Hindu Kush Himalaya region that cover 60,054 square kilometers. Many of these glaciers are experiencing ice loss that will eventually prove to be devastating. Since the 1960s, glaciers around the world have lost four thousand cubic kilometers of water. In the 1990s, this loss was twice as fast as in previous decades. Glaciers in the Himalayas retreat thirty to forty meters every year. Glaciers are melting because of global warming. Global warming is caused by an increased production of carbon dioxide, combustion of fossil fuels, and global deforestation (Hudson and Shrestha, 2018). Increasing temperatures caused by climate change do not allow snow to accumulate to create or grow existing glaciers. Higher temperatures cause snow and ice to melt, destroying glaciated areas and further increasing average temperatures. The icy, light colored surface of glaciers absorb twenty percent of the sun's heat and reflect eighty percent back. Without glaciers, the land will absorb the majority of this heat and will become hotter (Mahapatra, 2019).

IV. REFERENCES

Agarwal, A., M.S. Babel, S. Maskey. (2014), Analysis of future precipitation in the Koshi river basin, Nepal, Journal of Hydrology, 513, 422-434, doi: https://doi.org/10.1016/j.jhydrol.2014.03.047

Arita, K., Hayashi, D., & Yoshida, M. (1982), Geology and structure of the Pokhara-Piuthan area, central Nepal. Jour. Nepal Geol. Soc, 2, 5-29.

Bajracharya, S.R., S.B. Maharjan, F. Shrestha, W. Guo, S. Liu, W. Immerzeel, and B. Shrestha. (2015), The glaciers of the Hindu Kush Himalayas: current status and observed changes from the 1980s to 2010, International Journal of Water Resources Development, 31:2, 161-173, DOI: 10.1080/07900627.2015.1005731

The complete list of references will be featured in the final paper of this Scientific Journal.