THE SCHOOL FOR FIELD STUDIES

Freshwater Ecosystems
SFS 3211

Syllabus, Summer 2021

The School for Field Studies (SFS)
Center for Conservation and Development (CCD)
Siem Reap, Cambodia

This syllabus may develop or change over time based on local conditions, learning opportunities, and faculty expertise. Course content may vary from year to year.

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COURSE CONTENT SUBJECT TO CHANGE

Please note that this is a copy of a recent syllabus. A final syllabus will be provided to students on the first day of academic programming.

SFS programs are different from other travel or study abroad programs. Each iteration of a program is unique and often cannot be implemented exactly as planned for a variety of reasons. There are factors which, although monitored closely, are beyond our control. For example:

- Changes in access to or expiration or change in terms of permits to the highly regulated and sensitive environments in which we work;
- Changes in social/political conditions or tenuous weather situations/natural disasters may require changes to sites or plans, often with little notice;
- Some aspects of programs depend on the current faculty team as well as the goodwill and generosity of individuals, communities, and institutions which lend support.

Please be advised that these or other variables may require changes before or during the program. Part of the SFS experience is adapting to changing conditions and overcoming the obstacles that may present. In other words, the elephants are not always where we want them to be so flexibility is key.

Course Overview

Freshwater ecosystems are amongst the most important and productive ecosystems. They support tremendous biodiversity and provide food security to millions of people, many of whom live in some of the world's poorest nations. Despite this, the millennium development goals for biodiversity completely neglected freshwater systems, and it is only now emerging on the global agenda. This lack of attention has resulted in fewer freshwater protected areas compared to terrestrial biome. In addition, a critical knowledge gap in the conservation of freshwater ecosystems exists because the majority of research and conservation efforts have concentrated on terrestrials or marine systems.

Cambodia is home to one of the highest levels of biodiversity and productivity of freshwater ecosystems in the world. The Cambodian Tonle Sap-Lower Mekong River system is driven by an annual flood pulse hydrological system which results in rich spawning grounds for fishes and high nutrient loads for rice production. This system produces one of the world's largest inland fisheries and an importance source of food security to the Cambodians: over 70% of the population's protein intake derive from fisheries resources from this system.

The Tonle Sap-Lower Mekong River ecosystem is currently threatened by numerous changes such as intensive agriculture practice and infrastructure developments, which have altered the country's land use, forest cover, water quality, and subsequently affected food security and biodiversity in the region. It is critical to understand the importance of these ecosystems and the ecological and social-political dynamics that support food security upon which millions of rely on for their survival and their livelihoods.

This summer course will use case studies from the Tonle Sap Lake and the Mekong River to explore and examine the nexus of ecology, hydrology, resource management, conservation policy, and governance to address complex environmental issues of this important tropical freshwater ecosystem. Throughout the course, students will travel to different parts of Cambodia to visit conservation sites where they will investigate and learn about freshwater ecosystem ecology and hydrology, identify ecosystem services, explain major sources of pressure and challenges, critically evaluate cross-cutting environmental issues, and discuss solutions conserve tropical freshwater ecosystems. Students will develop critical thinking skills needed to take informed positions on the ongoing environmental issues around freshwater ecosystems. Toward the end of the course, students will work in small groups to design conservation projects that have potential to address some of the local conservation issues they encountered throughout the course.

Some of the places we will visit:

- The world heritage Angkor wat: a century old temple of the Khmer empire
- The Tonle Sap lake: the largest freshwater lake in Southeast Asia

- The Mekong River: the third fish diverse river in the word
- Endangered species conservation sites: freshwater dolphin pool, former Canto's giant softshell turtle conservation center, Ramsar site
- The Lower Sesan 2 Dam: hydropower dam on a major tributary of the Mekong River
- Royal University of Phnom Penh: the largest and oldest university in Cambodia
- Villages along the Mekong River and the Tonle Sap Lake
- Cultural and historic sites: S21 genocide museum, royal palace

Learning Objectives

Upon completion of this course, students will be able to:

- Connect the culture and history of Cambodia to the current conservation issues and environmental outcomes
- Identify key aquatic species, invasive species, and endangered species of South East Asia
- Apply both quantitative and qualitative scientific research skills related to freshwater systems
- Explain the link between biophysical dynamics of tropical freshwater ecosystems, food security, and local livelihood outcomes
- Discuss the consequences of hydropower development in relation to issues of social justice, livelihood change, and climate change
- Analyze environmental impacts of development projects and debate conservation benefits in the face of development demands
- Design a conservation project proposal to address one of the ongoing local freshwater ecosystem conservation issues

Assessment

Assessment Item	Value (%)
Nature field journal	15
Field exercise 1: Macroinvertebrate & water quality	10
Field exercise 2: Fish morphology	10
Field exercise 3: Water bird populations	10
Field exercise 4: Environmental impact assessment	20
Dolphin conservation debate	10
Conservation grant proposal report & presentation	25
TOTAL	**100**

Assessment Descriptions

Nature field journal: A field journal is used by naturalists and biologists to record their field experiences and observations. You will keep a field journal for all field trips including trips to:, Kompong Khleang, Kompong Phulk, Prek Toal, Chreav Rice Field, Stung Treng Ramsar Site, the

Lower Sesan 2 dam, former Canto's giant softshell turtle conservation center, and Kratie Irrawaddy dolphin conservation site. For each field trip, you will record your own observations and descriptions of natural environments you encounter (e.g. a species or a habitat). For each journal entry, you also include basic information such as time, date, locality, route, weather, habitat, list of species, vegetation, sketches, photos, and/or maps. The journal will be collected for review and graded throughout the course

Field exercises: Four field exercises (FEXs) will be assigned throughout the program. For the first FEX, you will work in pairs to survey macroinvebrates and identify them under a microscope. You will also collect water parameter data such as dissolved oxygen, turbidity, depth, conductivity, pH, and temperature. Then, you will assess water quality based on the presence of macroinvebrates as bioindicators. For the second FEX, you will be asked to take morphological measurements of a fish species from the Tonle Sap Lake during the field trip to Kompong Kleang, a village located on the floodplain habitat of the lake. Then you will perform a statistical analysis using morphological data collected to classify fish species based on their morphological characteristics. For the third FEX, you will be assigned to conduct an assessment of a waterbird monitoring program in the Prek Toal conservation area of the Tonle Sap Lake. In addition, you will be tasked to estimate and analyze population data of the birds being monitored using quantitative methods. For the fourth FEX, you will be asked to carry out an environmental impact assessment of the Lower Sesan 2 dam on the Sesan River, a major tributary of the Mekong River located in Stung Treng province.

Conservation project grant proposal: For this project you will work as a team with two or three other students. This assignment requires your team to develop a conservation plan for a local freshwater ecosystem issue. Each group will visit and choose from one of the local conservation sites where there are ongoing conservation efforts to conserve a habitat and endangered species populations. At each conservation site, you will meet and interview representatives from conservation organizations, government officials (e.g. Department of Environment), and project implementers (e.g. park rangers). This assignment requires each student group to write a grant proposal to submit for funding for the project implementation. The primary goal is for you to understand the process of grant proposal writing as well as to learn how to coordinate the many kinds of actors and conditions that conservationists often face when implementing a plan or writing a grant proposal. Teamwork will be essential for this project. Each group will make an oral and visual presentation to their classmates about their respective conservation project.

Dolphin conservation debate: you will participate in a debate about the dolphin conservation program in Cambodia. You will work in two groups to prepare for the debate. You will review literatures, articles, and news clips to prepare your arguments to support their position. More details will be provided in class.

Grading Scheme

A	95.00 – 100.00%	B+	86.00 – 89.99%	C+	76.00 – 79.99%	D	60.00 – 69.00%
A-	90.00 – 94.99%	B	83.00 – 85.99%	C	73.00 – 75.99%	F	0.00 – 59.99%
		B-	80.00 – 82.99%	C-	70.00 – 72.99%		

General Reminders

Readings: You are expected to have read all the required articles / book chapters prior to each class. Information from required readings will be part of the course assessments. All readings are available as PDFs on the Student Drive or from a common laptop. It is encouraged that 'optional readings' be reviewed by students. The reading list might be updated or changed during the course period and some readings that are initially listed as 'optional' may be changed to 'required'.

Plagiarism: Using the ideas and material of others without giving due credit, is cheating and will not be tolerated. A grade of zero will be assigned if anyone is caught cheating or aiding another person to cheat actively or passively (e.g., allowing someone to look at your exam). All assignments unless specifically stated should be individual pieces of work.

Deadlines for written and oral assignments are instated for several reasons: They are a part of working life to which students need to become accustomed and promote equity among students, and deadlines allow faculty time to review and return assignments before others are due.

Assignments will be handed back to students after a one-week grading period. Late assignments will incur a 10% penalty for each day that they are late. No assignment will be accepted after three days.

Participation: Since we offer a program that is likely more intensive than you might be used to at your home institution, missing even one lecture can have a proportionally greater effect on your final grade simply because there is little room to make up for lost time. Participation in all components of the program is mandatory because your actions can significantly affect the experience you and your classmates have while at SFS. Therefore, it is important that you are prompt for all land and water based activities, bring the necessary equipment for field exercises and directed research, and simply get involved.

Course Content

Lecture Title and Description	*Formats (Hours)*	*Readings*	*Location/ Field Trips/ Assignments*
Program Orientation			Siem Reap
Cambodian History Overview & Cultural Norms • A timeline of events from the Angkorian era to the present • Brief introduction to Cambodian cultural norms	Guest lecture + field component (3.0)	Chandler 2007	Siem Reap/ Downtown, Pagoda
Khmer Language Introduction • Language structures • Basic vocabularies • Daily basic conversations	Guest lecture + field component (3.0)		Siem Reap/ Local market
The Angkor Empire • Overview of the Angkorian empire- the rise and fall of the empire	Guest lecture + field component (4.0)	National Geographic 2009 Petrotchenko 2014	Siem Reap/ Angkor Wat Complex
Course Introduction: • Freshwater Ecosystems • Cambodian Protected Areas • Field journal • Field exercises • Grant proposal	Lecture (1.5)	Syllabus	Siem Reap
Tonle Sap Lake Ecosystem • Hydrologic cycle • Aquatic plants and primary productions • Eutrophication	Lecture (1.5)	Campbell et al. 2006 Dudgeon et al. 2006	Siem Reap
Invasive species of the Tonle Sap Lake • Origins • Threats • Control mechanisms & management plan	Lecture (1.5)	Zalinge 2006	Siem Reap

Lecture Title and Description	*Formats (Hours)*	*Readings*	*Location/ Field Trips/ Assignments*
Macroinvetebrate and Water Quality of the Tonle Sap Lake: Kompong Kleang case study • Macroinvetebrate identification • Water quality parameters • Field sampling techniques	Lecture + Guest lecture + field component (3.0)	Chheng et al. 2014 Sor et al. 2017 Sor et al. 2018	Siem Reap/ Kompong Kleang Stilted Village/ Fex 1
Fish of the Tonle Sap Lake: Prek Toal case study • Fish species identification • Morphological diversity • Fishing-down-the-food-web model • Seasonality and fish assemblage	Lecture + field component (5.0)	Ngor et al. 2018 Pauly et al. 1998 Pool et al. 2019	Siem Reap/ Prek Toal Floating Village/ Fex 2
Water Bird Monitoring of the Tonle Sap Lake: Prek Toal case study • Monitoring techniques • Monitoring framework • Population estimates and analyses	Lecture + Guest lecture + field component (5.0)	Seak et al. 2011	Siem Reap/ Prek Toal Floating Village/ Fex 3
Flood Pulse Ecosystem & Food Security of Tonle Sap Lake: Chreav rice field case study • Flood pulse system • Fish production • Rice production • Livelihood Framework • Interview techniques	Lecture + Field component (4.0)	Arias 2013 Chea et al 2016 Holtgrive et al. 2013 Hortle et al. 2008	Siem Reap/ Chreav Rice Farm Reap
Community-based natural resources management of the Tonle Sap Lake: Kompong Phluk case study • Tragedy of the commons • Common pool resources • Fisheries management • Ecotourism • SWOT analysis	Lecture + field component (4.0)	Hardin 1968 Ostrom 2009 Ratner 2011 Cooperman et al. 2012 Sithirith 2016 Kry et al. 2020	Siem Reap/ Kompong Phluk Stilted Village Tragedy of the common game

Lecture Title and Description	*Formats (Hours)*	*Readings*	*Location/ Field Trips/ Assignments*
Grant Proposal Workshop • Project goals and objectives • Logical framework • Budget plan • Stakeholders	Lecture (2.0)	Conservation Leadership Program/ Rufford Small Grant for Nature	Siem Reap/ Group Work
Mekong River Ecosystem • River Ecology • River Food Webs • Freshwater Ecosystem Services	Lecture + field component (3.0)	Ou & Winemiller 2016 Saenz et al. 2016 Ou et al. 2017	Stung Treng/ Mekong Ramsar Site, Fish landing site
Hydrology & Water Governance of the Mekong River Basin • Hydropower developments • Transboundary water governance • Water rights	Lecture + field component (3.0)	Campbell 2009: chapter 4 Dore 2012 Ziv et al. 2012 Siciliano et al. 2015	Cambodia-Laos border/ Role play
Hydropower Development in Cambodia: Lower Sesan 2 Dam case study • Energy, hydropower and climate change • Development and displacement • Indigenous livelihoods and land rights • Timber, deforestation and land concessions	Lecture + guest lecture+ field component (6.0)	Baird 2016. Keeton-Olsen and Tran Techseng 2020. RFA, 2017	Stung Treng/Lower Sesan2 Dam Kbal Romeas Chas/ Srai Kor Chas Fex 4 A river change course film

Lecture Title and Description	*Formats (Hours)*	*Readings*	*Location/ Field Trips/ Assignments*
Biodiversity of the Mekong River Basin: Irrawaddy Dolphin and Canto's softshell turtle case studies • Endangered species • Species conservation strategies • Development vs. biodiversity	Lecture + guest lecture+ field component (5.0)	Hogan et al. 2004 Winemiller et al. 2016	Kratie/ Irrawaddy Dolphin Conservation Site/Former giant softshell turtle conservation center Group Debate
Climate Change and Freshwater Ecosystems • Climate change and livelihoods along the Mekong • From forests to industrial plantations: impacts on rivers • Prey Lang and shifting livelihoods	Lecture + guest lecture+ field component (4.0)	Scheidel and Work 2018 Diepart et al. 2019	Kratie/ Koh Pdau/ Achen/ Prey Lang
The Future of Freshwater Ecosystem Conservation • Conservation challenges and opportunities • Lesson learnt/not-learnt	Lecture + guest lectures (2.0)		Phnom Penh/ Visit with Stakeholders/ Grant proposal presentation
Cambodian Recent History and Culture • The Khmer Rouge regime • Urban lives	Guest lectures + field component (2.0)	Ung 2000 Ung 2005 Brinkley 2011	Phnom Penh/ S21 prison, Royal palace First they killed my father film
Learning Reflection and Program Wrap-up • Program feedback • Disorientation • Report card			Phnom Penh/ Farewell dinner
Total Contact Hours	62.5		

Primary Readings

Arias, M. (2013). Impacts of hydrological alterations in the Mekong Basin to the Tonle Sap Ecosystem. Dissertation. University of Canterbury. New Zealand.

Baird, I. G. (2016). Non-government Organizations, Villagers, Political Culture and the Lower Sesan 2 Dam in Northeastern Cambodia. *Critical Asian Studies*, 48(2), 257-277.

Brinkley, J. (2011). Cambodia's curse: The modern history of a troubled land. New York: Public Affairs.

Campbell, I. C., Poole, C., Giesen, W., & Valbo-Jorgensen, J. (2006). Species diversity and ecology of Tonle Sap Great Lake, Cambodia. *Aquatic Sciences*, 68(3), 355-373.

Campbell, I. C. (Ed.). (2009). The Mekong: biophysical environment of an international river basin. Academic Press, 464 pp.

Chandler, D. (2007). A History of Cambodia: Fourth Edition. Boulder: Weastview Press.

Chea, R. et al. 2016. Toward an ecological understanding of a flood-pulse system lake in a tropical ecosystem: Food web structure and ecosystem health. *Ecological modelling, 323, 1-11.*

Chheng P., et al. (2014). Report on the 2011 Biomonitoring Survey of the Lower Mekong River and selected tributaries, MRC Technical Paper No. 43. Mekong River Commission, Vientiane, 78 pp.

Cooperman, M. S., et al. (2012). A watershed moment for the Mekong: newly announced community use and conservation areas for the Tonle Sap Lake may boost sustainability of the world's largest inland fishery. *Cambodian Journal of Natural History*, 2: 101-106.

Diepart, J.-C., Ngin, C., & Oeur, I. (2019). Struggles for life: Smallholder farmers' resistance and state land relations in contemporary Cambodia. *Journal of Current Southeast Asian Affairs*, 38(1), 10-32.

Dore, J., Lebel, L., & Molle, F. (2012). A framework for analyzing transboundary water governance complexes, illustrated in the Mekong Region. *Journal of Hydrology*, *466*, 23-36.

Dudgeon, D. et al. (2006). Freshwater biodiversity: importance, threats, status and conservation challenges. *Biological reviews*, *81*(2), 163-182.

Hogan, Z. S., Moyle, P. B., May, B., Zanden, M. J. V., & Baird, I. G. (2004). The imperiled giants of the Mekong: Ecologists struggle to understand—and protect—Southeast Asia's large migratory catfish. *American Scientist*, *92*(3), 228-237.

Hardin, G. (1968) The tragedy of the commons. *Science*, 162:1243-1248.

Hortle K.G., Troeung R., & S. Lieng (2008) Yield and value of the wild fi shery of rice fields in Battambang Province, near the Tonle Sap Lake, Cambodia. MRC Technical Paper No.18. Mekong River Commission, Vientiane. 62 pp

Holtgrieve G. W., et al. (2013) Patterns of Ecosystem Metabolism in the Tonle Sap Lake, Cambodia with Links to Capture Fisheries. *PLoS ONE* 8(8): e71395.

Keeten-Olsen D. & Techseng T. (2020). Indigenous Residents at Sesan Dam Prepare for New Fight. Voice of Democracy.

Kry, S., et al. (2020). Assessment of the changing levels of livelihood assets in the Kampong Phluk community with implications for community-based ecotourism. *Tourism Management Perspectives*, *34*, 100664.

National Geographic. (2009). Angkor interactive. Retrieve at http://ngm.nationalgeographic.com/2009/07/angkor/angkoranimation.

Ngor, P. B., et al. (2018). Fish assemblage responses to flow seasonality and predictability in a tropical flood pulse system. *Ecosphere*, *9*(11), e02366.

Ostrom, E. (2009). A general framework for analyzing sustainability of social-ecological systems. *Science*, *325*(5939), 419-422.

Ou, C., C. G. Montaña., & K. O. Winemiller. 2017. Body size–trophic position relationships among fishes of the Lower Mekong Basin. *Royal Society Open Science* 4: 160645.

Ou, C. & K.O. Winemiller. 2016. Seasonal hydrology and shifts in production sources supporting fishes in the Lower Mekong River Basin. *Canadian Journal of Fisheries and Aquatic Science* 73: 1-21.

Pauly, D. et al. (1998). Fishing down marine food webs. *Science*, *279*(5352), 860-863.

Petrotchenko, M. (2014). Focusing on the Angkor temples: The guidebook (3rd Edition).

Pool, T., et al. (2019). Fish assemblage composition within the floodplain habitat mosaic of a tropical lake (Tonle Sap, Cambodia). *Freshwater Biology*, *64*(11), 2026-2036.

Ratner, B. D. (2011). Common-pool resources, livelihoods, and resilience: Critical challenges for governance in Cambodia (No. 1149). International Food Policy Research Institute (IFPRI).

RFA (2017). Cambodia's Lower Sesan 2 Dam Reservoir Used to Launder Illegal Timber: Police. Radio Free Asia.

Saenz et al. (2016). Mapping potential freshwater services, and their representation within Protected Areas (PAs), under conditions of sparse data. Pilot implementation for Cambodia. *Global Ecology and Conservation*, 7, 101-122.

Scheidel, A., & Work, C. (2018). Forest plantations and climate change discourses: New powers of 'green'grabbing in Cambodia. *Land Use Policy*, 77, 9-18.

Seak, S., Schmidt-Vogt,D., & Thapa, G.B. (2011) A comparison between biodiversity monitoring systems to improve natural resource management in Tonle Sap Biosphere Reserve, Cambodia, *International Journal of Biodiversity Science, Ecosystem Services & Management*, *7*(4), 258-272.

Siciliano, G., Urban, F., Kim, S. & Lonn, P. (2015). Hydropower, social priorities and the rural–urban development divide: The case of large dams in Cambodia. *Energy Policy* 86: 273–285.

Sithirith, M. (2016). Political Economy of Fishing Villages: A Case Study in the Tonle Sap Lake, Cambodia. *Journal of Environmental Science and Engineering*, 299-313.

Sor, R., et al. (2017). Spatial organization of macroinvertebrate assemblages in the Lower Mekong Basin. *Limnologica*, *64*, 20-30.

Sor, R., Legendre, P., & Lek, S. (2018). Uniqueness of sampling site contributions to the total variance of macroinvertebrate communities in the Lower Mekong Basin. *Ecological indicators,* 84, 425-432.

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Ung, L. (2005). Lucky child: A daughter of Cambodia reunites with the sister she left behind. New York: HarperCollins.

Winemiller, K.O. et al. (2016). Balancing hydropower and biodiversity in the Amazon, Congo, and Mekong: Basin-scale planning is needed to minimize impacts in mega-diverse rivers. *Science* 351 6269:128-129.

Zalinge van, R (2006). An assessment of exotic species in the Tonle Sap Biosphere Reserve and associated threats to biodiversity. A resource document for the management of invasive alien species. Wildlife Conservation Society, Phnom Penh, pp. 96.

Ziv et al. (2012). Trading-off fish biodiversity, food security, and hydropower in the Mekong River Basin. *Proceedings of the National Academy of Sciences of the United States of America* 109(15), 5609-5614.