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INTRODUCTION

This paper investigates the circulation of ecological knowledge and practices between North America and Southeast Asia via ecologists' involvement in the politics of science during the Transpacific Cold War. Historians have documented how American scientists in the early Cold War (1945–1965) faced the contradiction between their apparent 'freedom' to conduct research compared to scientists in socialist countries, on the one hand, and the imperative to depoliticise the connection between their research and the military-industrial complex, on the other hand.[1] Historians have also shown how the environmental, civil rights and antiwar movements severely challenged this apolitical science by the late 1960s.[2] The popularisation of ecology and its convergence with environmental politics after the 1970s are often viewed as part of this trend of repoliticising science in North America.[3]

However, this paper argues that the Cold War ideal of apolitical science did not just vanish from ecology, but traveled to Southeast Asia where ecological science had not yet joined forces with the environmental movements. The next section first outlines how the American military-industrial complex facilitated the rise of a particular school of ecology, systems ecology, and its ambition to enact technocracy, or governance through apolitical expertise. Nonetheless, in response to the challenges of social movements, ecologists started to distance themselves from this technocratic idea by transforming their field into a 'multidisciplinary' endeavor with the aim of creating a more democratic approach to environmental planning. Conversely, the second section demonstrates how the appeal of multidisciplinary approaches entered Southeast Asia mainly to justify ecologists' participation in developmental projects, without necessarily challenging the state's hegemony in policymaking. A third section investigates how ecologists in Thailand, the Philippines and Indonesia theorised the value of multidisciplinary research in the 1980s through the idea of the 'agroecosystem.' Finally, I situate the legacy of this apolitical ecology in contemporary debates about agroecology and stress the need to rediscover the democratic promise of multidisciplinary ecology.

MODELLING DIVERSITY

Since a detailed history of 'systems ecology' is beyond the scope of the paper, here I will focus on two ecologists, the brothers Eugene and Howard Odum. In 1954, they were hired by the Atomic Energy Commission (AEC) to survey the impacts of nuclear testing on Eniwetok Atoll, an opportunity they used to quantify the primary productivity of coral reefs, which became a paradigmatic case of systems ecology. Howard Odum's 1955 analysis of primary productivity in Silver Spring, Florida, was another paradigmatic case that depicted rivers entirely as energy and biochemical circulations. The survey of species and their relations that dominated interwar ecology was then replaced by the analysis of the aggregated properties of the whole system.[4]

In 1964, Eugene Odum coined the name "systems ecology" to describe this new school of ecology. He argued that the ecosystem had become a "basic unit of structure and function" in ecology, similar to cells in molecular biology.[5] In addition, he used advances in ecology to support his faith in technoscientific progress and proposed that the "net result of the atomic age should be favorable if new tools, such as radioactive tracers, and new thinking about the minimum ecosystem for man in space can be fully exploited in terms of man's continued survival in the biosphere."[6] Appealing to the field of cybernetics – the control of complex systems – which had emerged in military research during the 1940s and 50s, systems ecologists presented ecosystems as complex machines governed by feedback loops and circular causality. They then promoted the use of complex machines, namely computers, to simulate and optimise ecosystems. As philosopher Peter Taylor observed, ecologists in the 1960s consequently embraced a "technocratic optimism" which aspired to govern the environment according to apolitical expertise.[7]

Some historians argued that this enthusiasm for systems ecology had largely dissipated by the early1970s due to the ambivalent results of American participation in the International Biological Programme (IBP). Between 1968 and 1974, the United States Congress spent roughly 57 million dollars on developing large-scale biome models of arid land, grassland, forest and tundra. While the IBP offered unprecedented funding and networking opportunities, the models it produced were of little use to policymakers as a result of their lack of standardisation and socioeconomic contexts.[8] However, the environmental movements offered systems ecologists a second chance to influence society with their knowledge of ecosystem modelling. A new generation of ecologists thus began to adapt the cybernetic languages of their field into a multidisciplinary approach to policymaking.

The career of Canadian ecologist Crawford Holling testified to this new development. After establishing himself in the field of pest control, in the 1970s Holling developed the theory of "resilience," or "a measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables."[9] Having witnessed the side effects of narrow-minded technological applications, such as the ecological homogenisation and pesticide resistance induced by DDT and monoculture, Holling believed that ecologists should not attempt to lock a system in an equilibrium, but preserve its capacity to adapt to disturbance. While he was working at the University of British Columbia, Holling's collaborators extended his vision of resilience to policy issues ranging from grazeland management to urban planning, and emphasised how *democratic participation* can keep nature and society within the boundary of adaptation: "The democracy is boundary-oriented (like the grassland), and the dictatorship is equilibrium-centered (like the wheatfield). Democratic systems

appear purposeless, oozing from one compromise decision to another, but persisting. Dictatorships, or technocracies, are much more purposeful and goal-oriented (equilibrium-centered) but also much more vulnerable to overthrow or disruption."[10]

To avoid this "equilibrium-centered" mindset, Holling argued for dialogue and cooperation across disciplines through what he described as a "workshop" approach. In such a workshop, a group of experts would be invited to create models reflecting the concerns of their disciplines and, through debating the results of each model and realising their biases, use the lessons learned to "build the essential bridges between methods, disciplines, and institutions."[11] Moreover, echoing the growing emphasis on citizens' role in policymaking, Holling argued that a workshop must involve not only multidisciplinary experts, but also the public, so that it can accommodate not only "specific 'legitimate' vested interests," but "all vested interests," thereby achieving a "truly open access to information" and "a change in political and institutional structure that can threaten but also improve the political process."[12] Under this new paradigm, the heterogeneous grassland thus became a better model of policymaking than the monoculture of wheatfield, artificially kept at maximum productivity.

AGRICULTURE IN THE COLD WAR

As ecologists in North America steered their discipline away from technocratic ambitions, a related but different context emerged in Southeast Asia: to win the 'hearts and minds' of developing nations, in the 1950s and 60s, American philanthropic organisations, in particular the Ford and Rockefeller Foundations, worked with universities and governmental agencies to launch training and research programs in Asia and Latin America with the aim of increasing food productivity, a campaign often summarised as the "Green Revolution."[13]

Crucially, while social movements between 1966 and 1975 repoliticised science in North America, in Southeast Asia the ideology of apolitical science was reinforced by several geopolitical events of that decade: the anticommunist massacres under Suharto's New Order; the rise of Ferdinand Marcos's authoritarian rule; and Communist conquest in Vietnam, Laos and Cambodia. Among countries allied with the United States, science remained largely a state-led activity for national development. As a result, the technocratic origin of ecology was less a problem than a promise for the practical value of this relatively young field.

One leader of this nascent group of ecologists was Indonesian Otto Soemarwoto. Receiving his PhD from Berkeley in 1960 and director of the National Biological Institute (Lembaga Biologi Nasional) since 1964, Soemarwoto led a series of studies on *Imperata cylindrica*, a weed known locally as *alang-alang*. His team at the Institute of Ecology of Padjadjaran University not only identified factors affecting the germination of *Imperata cylindrica* including light requirements, bud color and position, shoot length and rhizome size, but also situated the data according to different control methods – cultural, mechanical and chemical – and farming variables such as labor availability, land size and degree of mechanisation.[14]

This study later caught the attention of Percy Sajise, a Filipino finishing his PhD in Cornell in 1972. For Sajise, *Imperata* was not only a weed, but "a secondary form of plant succession" created by "cultural practices such as shifting cultivation (deforestation and burning) as well as to frequent slashing." His dissertation aimed to examine *Imperata* at sites under different treatment regimes

– newly cut and burnt, deforested and abandoned, and deforested followed by a period of pruning – and devise corresponding control methods. By paying attention to those engaging in the 'slash-and-burn' agriculture that was often stigmatised by the government, in the late 1970s Sajise would launch an investigation into the gap between state policies and the reality of upland communities at the University of Philippines Los Baños (UPLB).

The Ford Foundation was arguably the most influential American institution supporting Sajise and Soemarwoto's work. In the 1970s, as the foundation created environmental assessment programs in North America such as Crawford Holling's modelling workshops, it also surveyed the environmental impacts of the Green Revolution in Southeast Asia. The Ford Foundation thereby laid the foundation for a transpacific network of ecological research. Notably, it was Gordon Conway, a British ecologist, who became the first to link the multiple institutions of the network. Conway began his career in the early 1960s at the Department of Agriculture of North Borneo, where he noticed the uneven impacts of insecticides in pest control. He then pursued a PhD on population modelling at University of California, Davis, and became associated with ecologists on the West Coast such as Holling, who brought to his attention the Ford Foundation's Southeast Asian programs.[15]

Conway's views on agriculture in developing countries resonated with Holling's idea of resilience. Based on the tradeoff "between productivity and stability" in ecosystems, he argued that projects aiming for "a shift in the natural balance to create semi-artificial ecosystems" would invariably face "serious instability."[16] If the problem with the Green Revolution was this obsession with productivity, Conway presented the multidisciplinary approach of ecology as a remedy which could expand the focus of agricultural development. Although Conway joined Imperial College London in 1969, his work still focused on the Asia-Pacific, and his vision would be implemented in the Ford-funded Multiple Cropping Project (MCP) of Chiang Mai University, Northern Thailand.

In many ways, the MCP transplanted Holling and Conway's multidisciplinary ecology to agricultural research. As a 1980 report reflected, the project analyzed the Chiang Mai Valley as a complex system that raised many questions "in basic science, in experimental methodology and in interdisciplinary interaction."[17] Since multiple cropping was an established practice in the region, the MCP did not intend to impose new production methods, but to evaluate holistically the strength and weakness of existing methods. The advantage of ecology, the report suggested, was to offer a multidisciplinary framework that brought together plant breeders, soil scientists, entomologists, economists and extension workers in the survey of land tenure, water availability, topographical layout of crops and farmers' concerns in adopting Green Revolution technology like high-yielding seeds and fertilisers.

Based on his experience in Chiang Mai, Conway proposed the approach of "agroecosystem analysis" in 1983 to further refine the multidisciplinary framework as a "genuine *interdisciplinary* interaction" which encompassed three steps: first, assembling a group of experts from different backgrounds to define "the objectives of the analysis and the relevant systems, their boundaries and hierarchic arrangement;" secondly, analyzing these system properties through "all the participating disciplines in terms of space, time, flows and decisions;" and finally, generating "a set of agreed key questions for future research or alternatively a set of tentative guidelines for development."[18] While refashioning the multidisciplinary method as interdisciplinary, in essence Conway faithfully reproduced Holling's workshop approach in agricultural development.

Even though this attempt to move beyond disciplinary boundaries was not new, Conway had undoubtedly contributed to the cross-fertilisation of agriculture and ecology in Southeast Asia by introducing "agroecosystem" as an umbrella term to cover the kaleidoscopic concepts – cropping system, farming system, agricultural system, agro-ecosystem – emerging in the aftermath of the Green Revolution. The agroecosystem served as a single, if loosely defined, subject and approach that helped ecologists justify their place in agricultural development and create a unique community. In 1982, six institutions, including Conway's MCP, Sajise's team at the UPLB and Soemarwoto's Institute of Ecology, formed the Southeast Asian Universities Agroecosystem Network (SUAN), thus marking the wider acceptance of ecologists' involvement in agricultural development.

ADAPTATION IMPERATIVE

Among the projects conducted by SUAN ecologists, Soemarwoto's examination of home gardens in rural Java was especially valued in international development circles. Significantly, as the large-scale, agrochemical-intensive monoculture promoted in Green Revolution programs came under increasing scrutiny by the 1980s, small-scale, low-input household gardens became a rising star in agricultural development.[19]

Soemarwoto's team focused on the *talun-kebun* agroecosystem in Java, which alternated between two components: household-managed forests (*talun*) composed of perennial trees providing timber, fibre and fruit; and garden plots (*kebun*) of annual vegetables and fruit created from fully or partially cleared *talun*. A well-managed *talun-kebun* thus served as a stable source of income and food between rice seasons. Apart from its subsistence and economic importance, Soemarwoto elucidated the benefits of *talun-kebun* in preserving genetic diversity and preventing soil erosion. The *talun-kebun*, he argued, was a dynamic production system grounded on farmers' ecological knowledge including the appropriate level of forest clearance, the times to plant and harvest certain garden species, the methods used to prepare and apply compost, and the skills of using bamboo to support the crops and create a multi-layer garden structure.[20]

While highlighting these ecological and economic advantages of *talun-kebun*, Soemarwoto lamented the appropriation of rural resources by plantations and hydroelectric dams promoted by urban policymakers who showed little appreciation for the "ecological wisdom of the people" and thus threatened the "stable and productive home garden system."[21] However, Soemarwoto's goal was not to reject development per se. In his view, the "exploitative relationship" between city and countryside was chiefly caused by asymmetrical information access, and the unbalanced distribution of power could be reformed by enabling villagers "to develop their capabilities in science, technology and organisation."[22] This emphasis on reform within the system was further manifested in Soemarwoto's insistence that, by offering "a stimulus to motivate people to work harder," the "gap" between the countryside and cities constituted not merely a barrier to, but also the *foundation* of, the improvement of rural livelihoods, and that a realistic policy should not aim to eliminate such a gap, but control it "within certain limits" by preventing the "collapse of the society" due to excessive exploitation.[23]

As a result, Soemarwoto's ideas echoed what Holling's collaborators called the "boundary-centered" approach, which preferred the maintenance of a dynamic, if uneven, system over the elimination of these system heterogeneities. In a constantly changing world, Soemarwoto posited ecologists' duty as steering "these changes for the better" and to "face the realities of the world."[24]

In this vision, social stability was to be achieved essentially by incorporating the knowledge of the local population.

By and large, Soemarwoto's view resonated with the strategy of combining development and ecology across the SUAN. In the introductory chapter to an edited volume published by the SUAN in 1984, Sajise praised Soemarwoto's research for elaborating how the ecological features of *talun-kebun* were "influenced by the social status, source of income, and educational background of the owner."[25] For Sajise, the study of Javanese home gardens captured a "circular causality" between the agroecosystem and social system in which "no prime mover status" could be "assigned a priori to any component or force within the total system." As a result, agriculture could not be approached through predetermined goals, but rather through dynamic flows of material, energy and information.[26] By studying the "relative balances of trade" of these systematic flows, ecologists could thus avoid the pitfalls of "many well-meaning attempts at agricultural development" in the past.[27]

Nevertheless, mirroring Soemarwoto's faith in reform within the system, Sajise argued that successful development would happen not by attacking the imbalanced "trade" itself, but by adapting governmental policies to local social and ecological peculiarities. Interestingly, he grounded his argument on an opposition between "Darwinian" and "Marxist" methods of social change: while Darwinism was seen as "probabilistic, multilineal, and continuous," Marxism was "deterministic, unilineal, and finalistic."[28] The equilibrium versus boundary approaches invoked by Holling then morphed into a choice between Marx and Darwin, and Sajise presented the Darwinian path as a better option in formulating adaptive policies.

In another chapter of the 1984 volume, Sajise recounted leading a multidisciplinary project in the Philippine uplands which included "grassland ecology, multiple cropping, reforestation, watershed management, drought tolerance, and soil fertility."[29] With the objective of understanding local farming practices, Sajise reiterated "that the position of the program is to relay the results of the study to the community where it was conducted and *not to decide for the community what must be done*."[30] While these results might or might not encourage communities to participate in local decision-making, the ecologist's job was not to facilitate such participation, but to discover the strengths and limitations of the system as a whole. Consequently, the value of multidisciplinary ecology remained its ability to bring together scientists from diverse backgrounds: whether it could bring together people and policymakers was a question that the communities involved had to figure out for themselves.

CONCLUSION: RECONTEXTUALISING MULTIDISCIPLINARY ECOLOGY

By 1990, due to diminishing funding in agricultural development in Southeast Asia following the end of the Cold War, the SUAN as a platform was replaced by a series of loose personal networks. Soemarwoto and Sajise remained influential leaders in ecology circles by rebranding their work as sustainable development, while Gordon Conway advanced his career in developmental agencies, ultimately becoming te president of Rockefeller Foundation in 1998. Since the 2010s, Conway's vision of the agroecosystem nonetheless began to be attacked by another group of ecologists from the American West Coast who identified themselves with the movement for 'agroecology.'

In his review of Conway's 2012 Book, *One Billion Hungry*, Eric Holt-Giménez criticised Conway for turning a blind eye to "the overwhelming financial power of neoliberal markets and chemical-based plantation agriculture" and attacked his "Doubly Green Revolution" that promised to reconcile peasant-led agroecological practices and industry-led biotechnology as an unrealistic proposal for "bringing an end to hunger without changing the agrarian status quo."[31] In a paper co-authored with his mentor, Miguel Altieri, Holt-Giménez suggested that the "academic and NGO-based history" of agroecology exposed the field "to financial and political cooptation from the food regime's reformist projects," and advocated for "strategic alliances with Radical food sovereignty struggles" to counter this co-optation.

Does such criticism suggest that, through its involvement in apolitical science in Southeast Asia, the democratic potential of multidisciplinary ecology ended up being co-opted into the program of multinational corporations? The picture is probably more complicated. Instead of blaming Cold War funding for neutralising the critical agenda of ecology, a constructive dialogue might be staged by contextualising the emergence, and divergence, of Conway's agroecosystem program and the agroecology of Holt-Giménez and Altieri. Importantly, when Altieri began his study of agroecology at Berkeley in the late 1970s, he also cited extensively from Conway's theory, especially on the properties of the agroecosystem.[32] If agroecology and the agroecosystem have shared roots in systems ecology, studying the ways in which different histories shaped their distinctive politics would be a valuable contribution to the debate. Further investigation is thus needed to determine how the context of Latin America during the 1980s, especially the rise of peasant-based activism to resist agribusiness, influenced the formulation of agroecology.[33]

To conclude, the promise of ecology in facilitating democratic participation is best seen as an ongoing project that, as Holt-Giménez rightly points out, is always entangled with both its history and the future it attempts to create. Apart from distinguishing the radical and reformist programs of ecology, inquiring into the politics of apolitical ecology might also help to rediscover a collective imagination for alternative social and environmental relationships.

Leo Chu is a PhD student in the Department of History and Philosophy of Science at Cambridge University. His interests cover the intersection of the history of science and environmental history in the late twentieth century. He also writes broadly about popular culture such as sci-fi films, anime and games. His work has been published in the *Journal of Planning History* and *Extrapolation*.

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