RMA

The Resource Modeling Association is an international association of scientists working at the intersection of mathematical modeling, environmental sciences, and natural resource management. We formulate and analyze models to understand and inform the management of renewable and exhaustible resources.

RMA Newsletter Spring 2021

#WCNRM 2021

by Felix Meier, Martin Quaas and Hanna Schenk

German Center for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig

The preparations for the first virtual World Conference on Natural Resource Modeling on "Tipping ecological-economic systems towards sustainability" are in full swing. We look forward to a variety of topics and speakers from all over the world.

If you haven't done so already, please remember to register before April, 30 at www.conftool.net/wcnrm2021. We expect around 60 talks, which will be distributed considering time zones into the two time slots (6:00 to 9:30 UTC and 14:30 to 18:00 UTC).

For PhD students there will be the possibility to present in a special PhD session, with discussant. As this year's conference will be fully virtual (via Zoom), there are no conference fees.

Please make sure you have a stable internet connection during the whole conference and especially during your talk. The conference program will be ready in early May at:

https://www.idiv.de/en/wcnrm2021.

We are pleased to hear four great keynotes from Yunne-Jai Shin (IRD, France), Stephen R. Carpenter (University of Wisconsin-Madison, USA), Marie-Catherine Riekhof (Kiel University, Germany) and Camilla Sguotti (University of Hamburg, Germany). Please check our website for updates www.idiv.de/wcnrm2021.

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PRESIDENT'S COLUMN

by Frank VAN LANGEVELDE

Since the beginning of 2020, we live an exceptional situation due to the coronavirus SARS-Cov2. I hope that you and your family are all doing fine. Many people work from home and are limited in their daily activities such as visiting family and friends. Scientific research helped society a lot by providing different vaccines and improved medications for treating Covid infections, which are great achievements. I hope that vaccination will allow to go back to our lives as before the start of the pandemic. In the meanwhile, many scientists study how to prevent such pandemic, especially the early detection of pathogen spill-over from wildlife to people and livestock.

From May 31 until June 4 2021, the next annual World Conference on Natural Resource Modeling will be organized in Leipzig, Germany. The conference is fully online and the registration is free of charge. I would like to ask all RMA members to register and present their recent investigations. The theme of the conference is "Tipping ecological-economic systems towards sustainability". As many natural resources around the world are being overexploited for short term economic benefits, ecosystems are on the brink of collapse. The aim of the conference is to discuss how to change ecological-economic system dynamics towards long-term sustainability. For example, several publications point at the relationships between the loss of biodiversity and the spread of zoonotic diseases. Members of the Resource Modelling Association (RMA) could contribute to these findings by modelling scenarios with a variety of measures to reduce the spread of zoonotic pathogens with a pandemic potential. During the conference, we can think as RMA about our role in preventing epidemics and pandemics, and how to mitigate the negative effects. I am looking forward to discuss during the conference how to model risks of infection in society and how to reduce these risks, to model spill-over and the evolution of pathogens in biodiversity hotspots, model potential outbreaks due to resource use, etc.
During the World Conference on Natural Resource Modeling in Leipzig, we are honoured to have 4 well-known keynote speakers: Yunne-Jai Shin (one of the lead authors of the IPBES report on biodiversity), Stephen Carpenter (emeritus director and professor at the Center for Limnology at University of Wisconsin-Madison, USA), Marie-Catherine Riekhof (professor of Political Economy and Resource Management at the Faculty of Agricultural and Nutritional Sciences at Kiel University, Germany) and Camilla Sguotti (empirical ecologist at the University of Hamburg, Germany). I trust that can set the stage for our thinking about tipping ecological-economic systems towards sustainability. The conference will be organized in a beautiful old German city and it is a pity that we cannot visit this place. I hope that we can experience the history and culture of Leipzig during the conference. I am looking forward to meet you all again online and enjoy a wonderful conference.

Let's use communication of the RMA through social media such as ResearchGate, LinkedIn and Twitter, which are open for your input. We can use these media to circulate information in line with the objective of the RMA, such as new academic positions, conferences, workshops, books, papers. It would be great if these media can also be used for topics related to the focus of the RMA to be discussed among the members and others. Let's share ideas about research on Covid-19!
The objective of the RMA is to foster research and teaching at the interface of ecology, economics, mathematics and computer sciences and devote to the sustainable management of natural resources and ecosystems. As members of the RMA we have the possibility to promote the global interest in sustainability and environmental issues. I am convinced that the RMA can help society in these unprecedented times. I hope that the upcoming online conference in Leipzig, the journal Natural Resource Modeling and social media will help us with this.
I want to send my very best wishes to everyone in the RMA community!

Frank van Langevelde
President RMA,
Professor Wildlife Ecology and Conservation
Wageningen University
The Netherlands

Catching-up with young awardees: Adam Thomas Clark

Assistant Professor at Karl-Franzens-Universität Graz (Austria)

We are glad to introduce in the newsletter, a new column dedicated to a former recipient of the Best Phd Student Presentation, during past WCNRM conferences. The purpose of the column is to catch up with former awardees , so if you're one of them, get ready !
In this issue, Adam Thomas Clark, kindly accepted to answer few questions.

RMA: *You've been awarded during WCNRM 2015 (World Conference on Natural Resource Modeling) held in Bordeaux, could you tell us a little bit more about you at that time and some memories about the conference ?*

Adam: I attended the WCNRM2015 as a fourth year PhD student at the University of Minnesota. My own work focused primarily on dynamical systems models of plant competition. I knew that I would need to graduate and find a postdoc position within the next few years, and the conference seemed like a good opportunity for me to get to know some new people, including potential supervisors, as well as a chance to learn about some different modelling perspectives.

RMA: *What happened since then ? What is your current position, what are your research fields and interests ? Could you briefly describe your journey in the resource modeling community?*

Adam: Somewhat unintentionally, the conference helped expose me to the broader European research community. I had combined the visit to Bordeaux with visits with several resource groups at iDiv in Germany and, among other things, the conference helped convince me that lots of great ecology was being done outside of the US. After graduating from my PhD in 2017, I ended up taking a postdoc position with Stan Harpole at iDiv, and spent two years researching empirically tractable frameworks for studying coexistence. And, finally, as of September 2020, I was hired as an assistant professor at the University of Graz in Austria.

RMA: *Are you a member of Resource Modeling Association and/ or are you still in touch with present RMA members ? Had RMA somehow helped you in a particular way ?*

Adam: No, sadly not. I'm afraid I largely lost contact as I was defending my PhD, though not for any fault of the organization – I just got caught up in other things.

RMA: *Have you attended to others WCNRM and will you recommend it to young researchers ? Could you give some advices to young students to improve their presentations or posters ?*

Adam: I haven't attended any other WCNRM conferences, though I can certainly say that I remember the experience fondly, and am grateful to have attended the conference in 2015. Among other things, it helped expose me to European science, and convinced me that Europe was an exciting place to go for my postdoc work.
My advice for students working on posters and presentations, especially those with a theoretical focus, would be to not get too bogged down explaining your methods. I love methods, and always wanted to show off all the cool little tricks and turns that I took in my modelling work – but, I've also almost never had anyone ever ask me a question about my quantitative methods in any talk I've ever given. Instead, at least in my experience, it is best to focus your time on explaining your research question, and on walking through the implications of your results. And, if anyone really has detailed questions about the methods themselves, it gives you a great opportunity to meet up later over a beer and geek out about modelling.

Thanks for all ! Best Regards .

Sustainability standards, multi-criteria maximin and viability

by Luc Doyen[1] & Pedro Gajardo[2]

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From the Brundtland Report and the conceptualization of sustainable development, many quantitative methods, metrics and criteria have been proposed and discussed to operationalize sustainability (Asheim,2007; De Lara and Doyen, 2008), in particular in the context of ecological and environmental economics. In that perspective, the discounted utility approach, qualified as a '*dictatorship of the present*' is criticized because this criterion neglects long-run utility, entailing unsustainable trajectories. Alternative approaches and criteria related to quantitative sustainability include the maximin (Solow, 1974), defined as the highest utility level that can be sustained over time, thus promoting intergenerational equity. Nevertheless, the use of optimization methods to quantify sustainability, including the maximin criterion, is globally criticized in Howarth (1995) who argue that sustainability conditions need to be imposed prior to the maximization of any social welfare function. In that regard, the account for biological, ecological or physical constraints to fulfill throughout time emerges as a crucial issue (Rockstrom and et al., 2009). See for instance Aichi Biodiversity Targets, formulated by the Convention on Biological Diversity. If the constraints induced by reference points, thresholds, boundaries, standards, or tipping points have to be satisfied over time, such problems related to sustainability can be formulated into the mathematical framework of viability theory (Aubin, 1990; Schuhbauer and Sumaila, 2016; Oubraham and Zaccour, 2018).

Doyen and Gajardo (2020) proved to what extent maximin and viability approaches are strongly entangled. It expands previous works of Doyen and Martinet (2012); Martinet and Doyen (2007). It relies on the following general model. We consider an ecological-economic systems described at time t by n stocks $x(t) \in \mathbb{R}^n$ such as natural resources or physical capital or labor, and m decision variables $a(t) \in \mathbb{R}^m$ including resource extraction, harvesting effort or consumption. All of the ecological-economic dynamics are represented by the following controlled discrete-time dynamic system

$$x(t+1) = D(x(t), a(t)), \qquad x(0) = x_0, \tag{1}$$

where function D captures stocks dynamics, including resource growth or investment while x_0 stands for the initial condition at time 0 of the system (or ecological-economic system).

Now consider at each period t, different payoffs, metrics or scores $I_j(x(t); a(t))$, which may depend on states and controls. Promoting intergenerational equity, the usual maximin approach aims at maximizing the minimal level over time of a specific payoff, say I_j. Now, adopting a strong sustainability viewpoint, aiming at balancing various payoffs related to several ecological and economic objectives within an inter-generational perspective, we investigate a multi-objective maximin problem. It relates to a maximin optimization problem that involves multiple metrics. In mathematical terms, such a problem can be formulated as

$$\mathcal{V}(x_0) = \sup_{(x(\cdot),a(\cdot))} \left(\inf_t I_1(x(t), a(t)), \ldots, \inf_t I_p(x(t), a(t)) \right), \tag{2}$$

under the dynamic constraints (1) and where the integer $p \geq 2$ is the number of objectives. Here, **we focus on Pareto (strong or weak) optimal solutions**, namely, solutions that cannot be improved in any of the objectives without degrading at least one of the other payoffs (Miettinen, 1999).

Let us now move towards the viable control approach. In such a framework, state and decision system variables have to comply with inequalities involving the different payoffs, metrics or scores I_j introduced previously (e.g., utilities, profits, production, consumption, stocks, etc.):

$$I_j(x(t), a(t)) \geq I_j^{\lim} \quad \text{for} \quad j = 1, \ldots, p \tag{3}$$

where I_j^{lim} are thresholds and standards not to exceed in order to avoid crisis and to guarantee the safety of the system. In that context, the so-called inverse via-bility problem consists in determining, given an initial condition x_0 at time 0, the constraints and standards, captured by the vector of thresholds I^{lim}, for which the dynamic system (1) mixed with constraints (3) is feasible. In more mathematical terms, the question consists in determining the following set of sustainable standards:

$$\mathcal{S}(x_0) = \left\{ I^{\lim} = (I_1^{\lim}, \ldots, I_p^{\lim}) \;\middle|\; \begin{array}{l} \exists \text{ controls } a(0), a(1), \ldots \text{ and states } x(0), x(1), \ldots \\ \text{satisfying dynamics (1) and constraints (3)} \end{array} \right\} \tag{4}$$

Doyen and Gajardo (2020) characterize the Pareto maximin $V(x_0)$ through static multi-criteria optimization problems over the set of sustainable standards $S(x_0)$. Such a finding allows us to interpret multi-criteria maximin as an extreme case of viability.

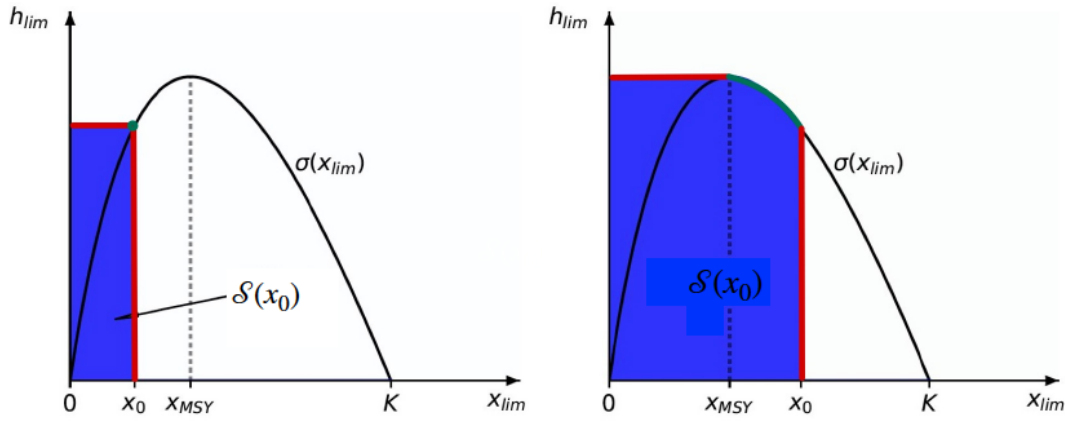


FIGURE 1. In blue the set of sustainable thresholds $S(x0)$; the Pareto maximin $V(x0)$ is the upper boundary of $S(x0)$; in red the weak Pareto boundary; in green the strong Pareto Boundary; (left) overexploitation case : $x_0 < x_{MSY}$; (right) underexploitation case : $x_0 > x_{MSY}$. The 'bell curve' stands for the equilibrium function $h = \sigma(x) = f(x) - x$.

Proposition For any initial conditions x_0, we have

$$\mathcal{V}(x_0) = \; Pareto\ boundary\Big(\mathcal{S}(x_0)\Big)$$

where the Pareto boundary of a set is again defined in the sense of Miettinen (1999). The Proposition can be interpreted as follows: multi-criteria maximin values $V(x_0)$ are the largest (in the Pareto sense) viable thresholds that can be sustained from initial state x_0 of the system. Doyen and Gajardo (2020) also proposed a numerical method based on dynamic programming to identify the sustainability standards.

Example for renewable resources management:

We illustrate both the interest and the computation of the set of sustainable standards and Pareto maximin for an example based on renewable resources management. We consider a regulating agency aiming at both the conservation and sustainable harvesting of the renewable resource. The stock of the renewable resource at time

t is represented by $x(t) \geq 0$, and its dynamics with harvesting $h(t)$ is described by

$$x(t+1) = f(x(t)) - h(t), \quad x(0) = x_0 \tag{5}$$

where f stands for the renewable function of the stock. The regulating agency intends to compute the multi-criteria maximin in terms of both stock and harvesting:

$$\mathcal{V}(x_0) = \sup_{(x(\cdot),h(\cdot)) \text{ satisfying } (5)} \left(\inf_t x(t),\ \inf_t h(t)\right). \tag{6}$$

Said differently, the social objective of the resource management consists in ensuring both current stock and catch. Figure 1 displays the set of sustainable thresholds $S(x_0)$in the following cases:

(i) $0 < x_0 < x_{MSY}$;
(ii) $x_{MSY} < x_0 < K$,

where x_{MSY} is the so-called maximum sustainable yield well-known in the bio-economic literature and the regulation of fisheries (Clark, 1990).

For this numerical example, we use the values r = 1.75 and K = 50 for the parameters underlying population renewal f (a Beverton-Holt function $f(x) = x + rx(1 + r/k\ w)^{-1}$). Using previous Proposition, we can deduce that the (strong) Pareto maximin boundary $V(x_0)$ (in green on the figure), equals the strong Pareto boundary (the 'right upper' part) of set $S(x_0)$. Interestingly, two contrasted situations for strong maximin multi-criteria can be distinguished with respect to the so-called maximum sustainable stock x_{MSY}.
In the first case, where the stock is in a situation of biological overexploitation in the sense that $x_0 < x_{MSY}$, there is a synergy between conservation and harvesting because the Pareto boundary of $S(x_0)$, located on the right-upper corner of the set, is reduced to a unique point. Such a synergy between resource conservation and production sustainability standards for over-exploited stocks sheds an important light on a potential ecolo-gical-economic reconciliation. In contrast, when the stock is biologically underharvested $x_0 > x_{MSY}$, a trade-off emerges between biological and production sustainability because the strong Pareto boundary of $S(x_0)$ corresponds to the decreasing concave curve located on the right-upper part of the set. In other words, rising stock conservation requirements x^{lim} alters the sustainable productive standard h^{lim} and conversely. In Doyen and Gajardo (2020), similar results are also obtained for a profitability goal instead of a catch requirement.

References

Asheim, G., 2007. Justifying, Characterizing and Indicating Sustainability. Sustainability, Economics, and Natural Resources, Springer-Verlag, Dordrecht.

Aubin, J.P., 1990. A survey of viability theory. SIAM J. Control Optim. 28, 749-788.

Clark, C.W., 1990. Mathematical bioeconomics. Pure and Applied Mathematics (New York). second ed.,John Wiley & Sons, Inc., New York.

De Lara, M., Doyen, L., 2008. Sustainable management of natural resource: mathematical models and methods. Springer, New York.

Doyen, L., Gajardo, P., 2020. Sustainability standards, multicriteria maximin, and viability. Natural Resource Modeling 33. URL: https://onlinelibrary.wiley.com/doi/abs/10.1111/nrm.12250.

Doyen, L., Martinet, V., 2012. Maximin, viability and sustainability. J. Econom. Dynam. Control 36, 1414-1430.

Howarth, R., 1995. Sustainability under uncertainty: A deontological approach. Land Economics 71,417-427.

Martinet, V., Doyen, L., 2007. Sustainability of an economy with an exhaustible resource: A viable control approach. Resource and Energy Economics 29, 17 - 39.

Miettinen, K., 1999. Nonlinear multiobjective optimization. volume 12 of International Series in Operations Research & Management Science. Kluwer Academic Publishers, Boston, MA.

Oubraham, A., Zaccour, G., 2018. A survey of applications of viability theory to the sustainable exploitation of renewable resources. Ecological Economics 145, 346 - 367.

Rockstrom, J., et al., 2009. A safe operating space for humanity. Nature 461, 472 - 475.

Schuhbauer, A., Sumaila, U., 2016. Economic viability and small-scale sheries - a review. Ecological Economics 124, 69-75.

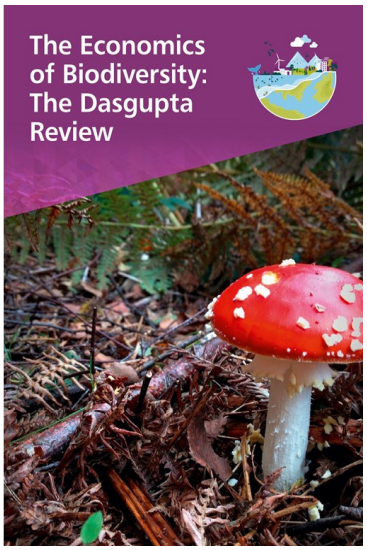
Solow, R., 1974. Intergenerational equity and exhaustible resources. Review of Economic Studies 41, 29-45.

A brief comment on :

The Economics of Biodiversity: The Dasgupta Review

by S. Lavaud

GREThA, University of Bordeaux , France.



front cover photograph©Will Jenkins

Commissioned by the UK Government in 2019, and published in february 2021, this independent, global review on economics of biodiversity produced by Professor Sir Partha Dasgupta, Frank Ramsey Emeritus Professor of Economics at Cambridge and Fellow of St John's College, is expected to help set the agenda for the UK Government's 25-year environment plan.

The landmark 600 pages review is organised in 3 parts: the first two parts, Foundations and Extensions, are remarkable report of clear economic analysis and up-to-date biodiversity science, while the third advances three main options for change.

In the Review's preface, Sir Dasgupta recalls how Nature has been excluded from economics models in the context of post World War II, where institutions were fighting against poverty and facing reconstruction needs. Therefore, the focus was on accumulation of both produced capital and human capital. In the 1970s, if Nature started to be integrated in macroeconomic models of growth, it still didn't appear as "*an essential entity of our economic lives*". Most standard models of economic growth and development disconnect Nature from society and fail to admit its limits, leading to a "*devastating ecological toll*": biological diversity is declining faster nowadays than at any time in our history.
Since 1970, there has been on average a 70% drop in the populations of mammals, birds, fish, reptiles, and amphibians. Almost a quarter of the global total of animal and plant species are assumed to be threatened with extinction.
The Review shows that between 1992 and 2014, pro duced capital per person doubled, at the expense of natural capital that declined by nearly 40%. Such decline is undermining Nature's productivity and resilience and in turn implies increasing risks and uncertainties for our economies

The Review argues that Gross Domestic Product is no longer fit for purpose when it comes to assess the economic health of nations, since it does not include depreciation of assets such as the degradation of biosphere. Dasgupta's starting point is to consider Nature as an asset, just as produced capital and humans are assets in economic framework, but it has to be outlined that Nature features are mobile, invisible, silent, differing greatly from produced capital goods. These features make it hard, often impossible to trace back the damages inflicted to the biosphere, giving rise to large externalities. Nature is studied in relation to other capital assets (not only through its use value but also its intrinsic worth), in a portfolio management perspective (thanks to some notably instructive summaries of assets management and portfolio choice theory).The role of biodiversity within this asset management framework is analogous to the role played by diversity within a traditional portfolio: it reduces risk and uncertainty.

Then the Review insists on the fundamental gap between society demand and Nature's supply. To sustain our natural assets and avoid net degradation, societal demand must be equal to, or less than, Nature's ability to regenerate and supply the goods and services we rely on. The first option for change to mitigate this discrepancy and warrant that our demand on nature does not exceed its sustainable supply is to widely increase natural assets' supply. This increase can result in improvement of Protected Areas (it is assumed that only 20% of P.A. are being well managed) by extending

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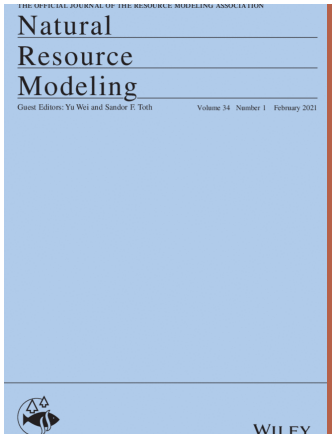

NRM Editor's Column

Special Issue for Systems Analysis in Forest Resources

by Shandelle M. Henson,

Editor-in-Chief

Volume 34, Issue 1 of Natural Resource Modeling (NRM), published February 2021, is a special issue devoted to forest resource modeling edited by Yu Wei and Sandor Toth.

The issue begins with an editorial by NRM associate editor Professor Yu Wei of the Department of Forest and Rangeland Stewardship, Warner College of Natural Resources, Colorado State University. Professor Wei's areas of research are landscape level forest management, wildland fire decision support, spatial optimization, and stochastic programming.

The contents of the issue are :

A learning heuristic for integrating spatial and temporal detail in forest planning, Eric B. Henderson and Howard M. Hoganson.

Multiobjective record-to-record travel metaheuristic method for solving forest supply chain management problems with economic and environmental objectives, Ji She, Woodam Chung, and Hector Vergara.

Optimizing surveillance and management of emerald ash borer in urban environments, Sabah Bushaj, I. Esra Büyüktahtakın, Denys Yemshanov, and Robert G. Haight.

Simulating the forest fuel market as a socio-ecological system with spatial agent-based methods: A case study in Carinthia, Austria, Johannes Scholz, Florian Breitwieser, and Peter Mandl.

Comparing contingency fire containment strategies using simulated random scenarios, Yu Wei, Matthew P. Thompson, Erin Belval, Benjamin Gannon, David E. Calkin, and Christopher D. O'Connor.

Protecting wildlife habitat in managed forest landscapes—How can network connectivity models help? Denys Yemshanov, Robert G. Haight, Rob Rempel, Ning Liu, and Frank H. Koch.

Studying the probability of spruce beetle caused mortality in Colorado's spruce forests using Bayesian hierarchical models, Warong Suksavate, Yu Wei, and John Lundquist.

Influence of rural labor migration behavior on the transfer of forestland, Hui Xiao, Caiwang Ning, Fangting Xie, Xiaolan Kang, and Shubin Zhu.

Connectivity at a cost: Economic dynamics of restoring habitat connectivity , Wisdom Akpalu and Jesper Stage.

A cycle-jumping method for multicyclic Hubbert modeling of resource production, Bolorchimeg N. Tunnell, James A. Conder, Ken B. Anderson, and Marek Locmelis

I appreciate the excellent work of Professor Yu Wei in assembling this issue, and I know you will enjoy it.

In closing, let me remind you that Natural Resource Modeling is now a full Gold Open Access journal. Papers published in NRM are immediately freely available to read, download and share. Open Access increases the visibility of your research, leading to more downloads and citations. Many funding agencies now require Open Access and we are pleased to have made this transition.

I look forward to receiving your submissions to NRM. Also, if you are interested in guest editing a special issue for 2022, please contact me.

Peace,

Shandelle M. Henson
Editor-in-Chief
Natural Resource Modeling

continued from p7)
them, favouring involvement of local communities into their management and funding them with sufficient resources. Improving the health of biosphere with restoration actions is also seen as an efficient tool since most of the global biodiversity lies outside Protected Areas. Nature based solutions for restoration have to be supported, since they've frequently been found to be more cost effective than engineered solutions and presented far fewer unexpected consequences, and that investment in natural capital has the potential for quick returns.

Another proposal lies into enacting policies that "*discourage*" damaging forms of consumption: food production is one of the most significant driver of biodiversity loss. As the global population grows, the problem of producing sufficient food in a sustainable manner will strengthen. Still, technological innovations can decrease the sector's contribution to climate change, reduce damaging inputs and improve production resilience system (e.g. through precision agriculture, integrated pest management and molecular breeding techniques...). But technological change is not the sole solution, the Review also claims for a restructuration of consumption and production patterns (change in prices and behavioural norms).

The second major recommandation is to change our measures of economic success to guide us on a more sustainable path. The Review advocates for an inclusive measure of wealth (by summing the accounting values of the tree forms of capital) that injects natural capital into national accounting as a crucial first step.

Lastly the third recommandation suggests to transform our institutions, financial and educational systems, noticing that neither top-down or bottom-up institutional structure are efficient enough to deal with nature degradation. The Review points to a need for supra-national institutional arrangements that may involve payment systems for countries to protect essential ecosystems within their boundaries and regarding ecosystems that spread outside national boundaries (such as oceans) a system of charges or rent for the use of their resources while banning any activities in their most sensitive areas. This systemic reform also implies empowering citizens to make informed choices by firmly establishing Nature studies in education policy. Dasgupta argues: "*The discipline to draw on nature sustainably must, ultimately, be provided by us as individuals. Many people have grown distant from nature.*"

The Dasgupta Review concludes: "*Correct economic reasoning is entangled with our values. Biodiversity does not only have instrumental value, it also has intrinsic worth – perhaps even moral worth. Each of these senses is enriched when we recognise that we are embedded in Nature. To detach Nature from economic reasoning is to imply that we consider ourselves to be external to Nature. The fault is not in economics; it lies in the way we have chosen to practise it* ".

The Economics of Biodiversity Review aims to create a new economic framework, firmly grounded in ecology, that guide ecologically responsible citizens through many options for achieving a more sustainable world (and incidentally provide a nice educationnal review for anyone interested in economics).

References:

Carrington, D. (2021, 02/02) *Economics of biodiversity review: what are the recommendations*, The Guardian, https://www.theguardian.com/environment/2021/feb/02/economics-of-biodiversity-review-what-are-the-recommendations

Dasgupta, P. (2021), The Economics of Biodiversity: The Dasgupta Review. (London: HM Treasury).

Dasgupta, P. (2021), The Economics of Biodiversity: The Dasgupta Review. Headline Messages (London: HM Treasury).

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