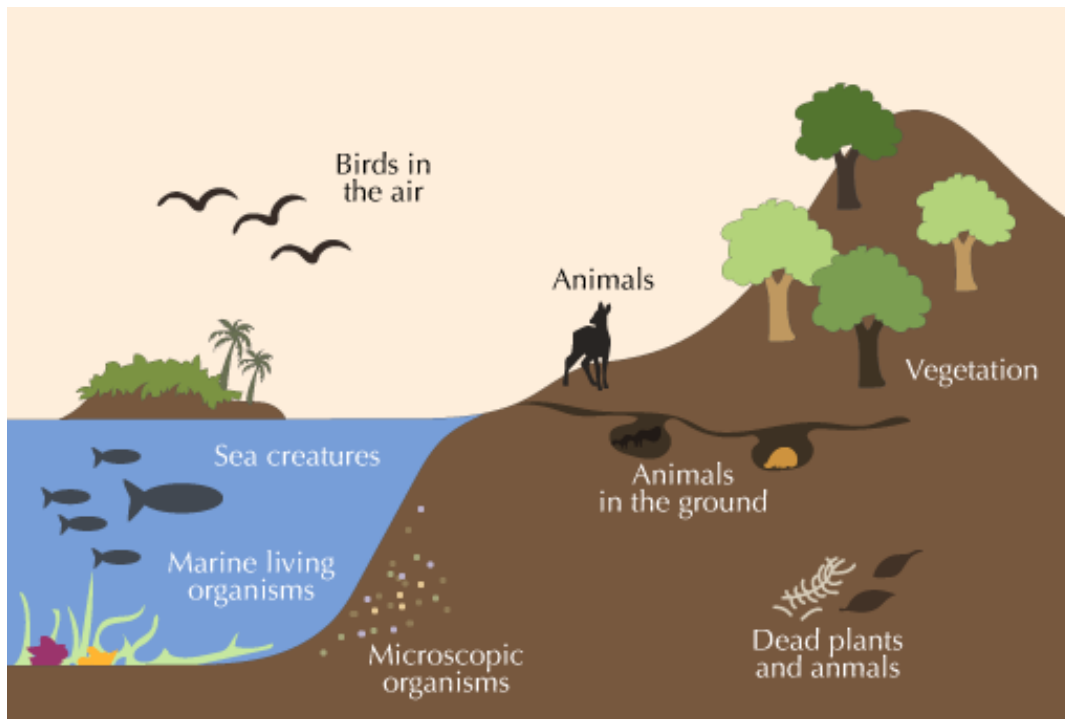


## Module 10: Health and Wellness as Ecosystem Services

Total contact time: 360 mins (2 weeks)

### I. Ecosystem Services

The earth consists of four (4) spheres. The biosphere is where all living components of the earth are found. The layer includes the air, water and land where various living forms thrive. It covers heights of several thousand meters above sea level where birds fly and up to the point where microbes can exist and several thousand meters more underneath the earth or below sea level where other organisms can also survive. These organisms are found in niches where they co-exist with other living forms in various relationships. All these living systems and their environment make up the ecosystem.



From: <http://eschooltoday.com/ecosystems/what-is-an-ecosystem.html>

#### What can we get from a healthy ecosystem?

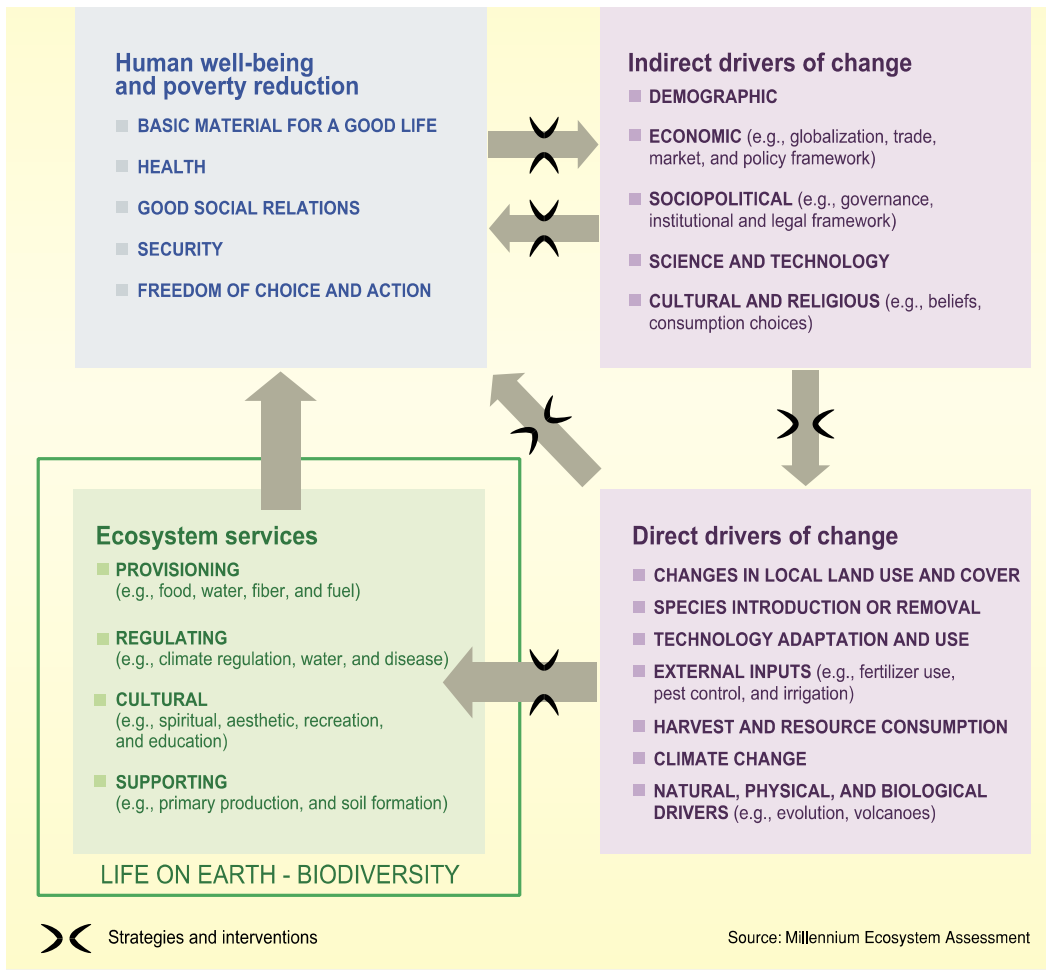
Ecosystems also interact with other ecosystems and the abiotic environment. A healthy ecosystem consists of various organisms engaged in complex sets of relationships between other living systems and its environment thereby producing various benefits termed ecosystem services. These services include the following: 1) provisioning such as food, clean and fresh water, fuel, wood, etc., 2) regulating such as those that regulate climate, disease, cleanliness, flood and other hazard controls; 3) cultural or aesthetic which also includes spiritual,

educational and recreational and 4) supporting which include nutrient cycling, production, etc. The first 3 directly benefit all living systems including humans while the supporting services are needed to ensure that the first 3 services are sustained (Millennium Ecosystem Assessment 2005: [http://pdf.wri.org/ecosystems\\_human\\_wellbeing.pdf](http://pdf.wri.org/ecosystems_human_wellbeing.pdf)). In 2001, various governments, private and non-government organizations, and scientists, worked together to conduct an integrated assessment of the status of ecosystems, the change it has undergone and the impact of such change for human well being. The assessment was aimed at providing various governments and policy-makers options available to help them conserve ecosystems and ensure sustainability of ecosystem services for human survival. The final report of the Millennium Ecosystem Assessment was released in 2005.

Ensuring sustainability of ecosystem services is crucial to human health and wellbeing. Forests provide food, oxygen, carbon sinks, livelihood and other resources while wetlands ensure clean water safeguarding against water-borne infectious organisms. Mangroves protect coastal areas from storm surges (<https://www.youtube.com/watch?v=BCH1Gre3Mg0>) while providing habitats for fishes and various marine resources. The microbiota in the gut contributes to nutrition by producing vitamins and aiding digestion and fermentation of food (<https://www.cbd.int/health/SOK-biodiversity-en.pdf>). The entire landscape produced by living systems provides a place for recreation, meditation, enhanced aesthetic aspirations and cultural identity – non-material benefits that is essential to psychological and mental wellbeing.

### *Why would drivers of change impact on biodiversity and ecosystem services?*

Living systems are tightly connected to their physical and material environment, i.e. living systems and the abiotic systems depend on each other for survival such that perturbations in living systems will affect the material world; on the other hand, changes in the physical environment will also affect living systems. Thus, natural calamities such as typhoons, earthquakes, volcanic eruptions, flooding, fire can disrupt ecosystems resulting in changes in adaptations and/or behavior patterns of living organisms. Humans are part of their ecosystem. He gets food and other products important for his day to day living from other living systems such as from trees in forests, or marine resources; he gets things for other basic needs such as shelter and clothing as well from non-living things. Nature also provides him with clean water from springs and other bodies of water. However, as man acquired the ability to utilize and manipulate his environment, i.e. both biotic and abiotic systems, the disturbance he has brought on the ecosystems and the biosphere in general is of such magnitude as to threaten not just the survival of the biosphere but consequently his own health and well-being and ultimately his survival. The figure below shows the interactions between biodiversity, ecosystem services, human well-being and drivers of change that indirectly or directly affect biodiversity.



Source: Ecosystems and human well-being: Biodiversity synthesis. Millennium Ecosystem Assessment p. iii. ([http://pdf.wri.org/ecosystems\\_human\\_wellbeing.pdf](http://pdf.wri.org/ecosystems_human_wellbeing.pdf))

This module takes off from Module 8: “Biodiversity and threats thereto” and Module 9: “Sustainable development” and describes the impact of living systems and disruptions of ecosystems to human health and wellness. Aside from this introduction to ecosystem services, it consists of 3 other topics as follows: 1) provisioning services for good nutrition and food security; 2) ecosystem services and human health and wellness; and 3) Aesthetic and cultural services and its impact on mental health. Each topic will contain a brief background or discussion with links to resources, activity(ies), and questions or tasks that a team of students needs to do.

## Learning Outcomes

At the end of this module, the student should be able to:

1. Examine various ecosystem services in their community that benefits human health and wellness.

2. Evaluate ecosystem disruption to services specifically on provisioning, regulating and cultural services as it relate to human health and wellness.
3. Assess changes in the environment and its impact on health and wellness, including nutrition, food security, and health using various global and local data.

## References

1. Chapter 3 and Ecosystem and Human Well Being: *Millennium Ecosystem Assessment 2005*:  
[http://pdf.wri.org/ecosystems\\_human\\_wellbeing.pdf](http://pdf.wri.org/ecosystems_human_wellbeing.pdf)
2. *Connecting Global Priorities: Biodiversity and Human Health. A State of Knowledge Review*. <https://www.cbd.int/health/SOK-biodiversity-en.pdf>
3. <https://www.youtube.com/watch?v=BCH1Gre3Mg0>
4. <http://www.scidev.net/global/biodiversity/feature/biodiversity-facts-and-figures-1.html>

## II. Ecosystem services 1: Provisioning for nutrition and food security

Before coming to class, read Chapter 6: “Biodiversity and Nutrition” of the review entitled “Connecting Global Priorities: Biodiversity and Human Health. *A State of Knowledge Review*” (p. 97-129). <https://www.cbd.int/health/SOK-biodiversity-en.pdf>.

1. List the factors that affect the provisioning services for the ecosystem. Classify them in terms of whether they are anthropogenic, biological (excluding man) or non-biological. Which of these factors has the highest impact on the ecosystem’s provision services? (Use a complex system model)

Read also the Executive Summary (p. 1-9) and Chapter 2: “Biodiversity and Human Health Linkages” (p. 28-43) of the review entitled *Connecting Global Priorities: Biodiversity and Human Health. A State of Knowledge Review*. <https://www.cbd.int/health/SOK-biodiversity-en.pdf>. and Chapter 8, Section 8.5 (p. 229-238) in the *Millennium Ecosystem Assessment 2005*.  
[http://pdf.wri.org/ecosystems\\_human\\_wellbeing.pdf](http://pdf.wri.org/ecosystems_human_wellbeing.pdf)

2. Why and how would biodiversity loss that results in the extinction of keystone species lead to malnutrition on one hand or over-nutrition/obesity on the other hand?

How healthy ecosystems ensure proper provisioning services, particularly good nutrition and clean water

Food, clean water, fuel, wood are provisioning services that sustains organisms making up the ecosystem. Living systems derive their food from other living systems such as plants that make food for organisms, usually animals, and other animals that predators prey on. Food sources also vary in their nutritional content thus a living system derives good nutrition by consuming various food sources. Since an ecosystem also contains various organisms in different habitats feeding on various food sources, a bio-diverse ecosystem provides good nutrition by delivering various choices or a mix of macro and micronutrients essential for growth, good health and well being of every organism in such an ecosystem. The figure (Fig. 1) below shows variations in the composition of three types of food.

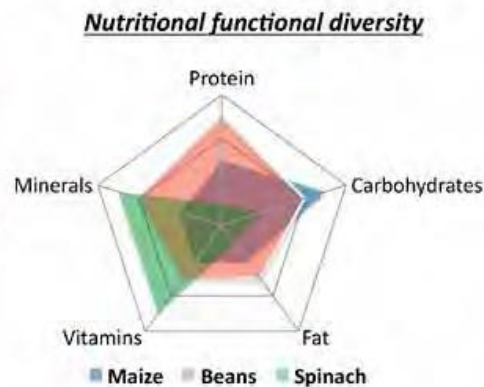


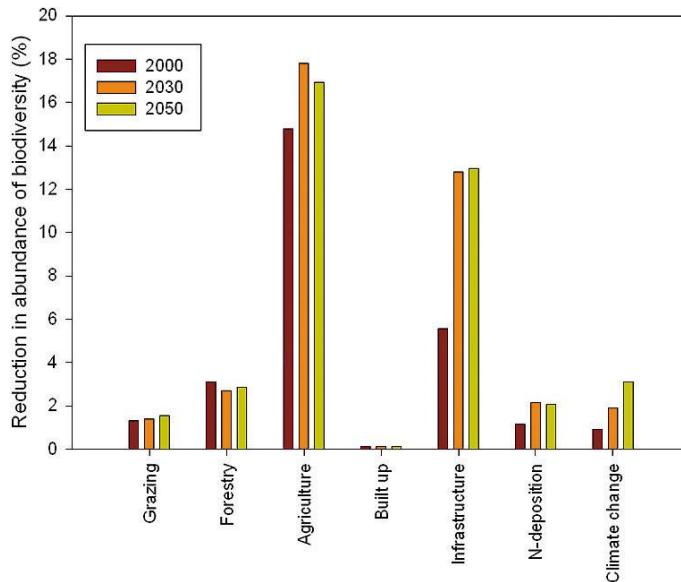
Fig. 1. Diversity of nutrients derived from three (3) different foods (Source: Remans, R. and Smukler, S. (2013))

Another provisioning services that is essential to good nutrition is clean water. Clean water is provided by a complex interaction of living systems and the ecosystem and the hydrologic cycle, as well. The quantity and quality of water is influenced by the quality and quantity of vegetation and forests as well. Loss of biodiversity can alter or disrupt these provisioning services resulting in health effects.

Is agriculture and aquaculture the answer to food security?

Worldwide, one of the major contributors to biodiversity loss is agriculture (fig. 2).

The relative significance of different direct causes for projected biodiversity loss in South East Asia, 2000-2050 (GLOBIO 3.0).



Source: GLOBIO 3.0, UNEP GRID-Arendal

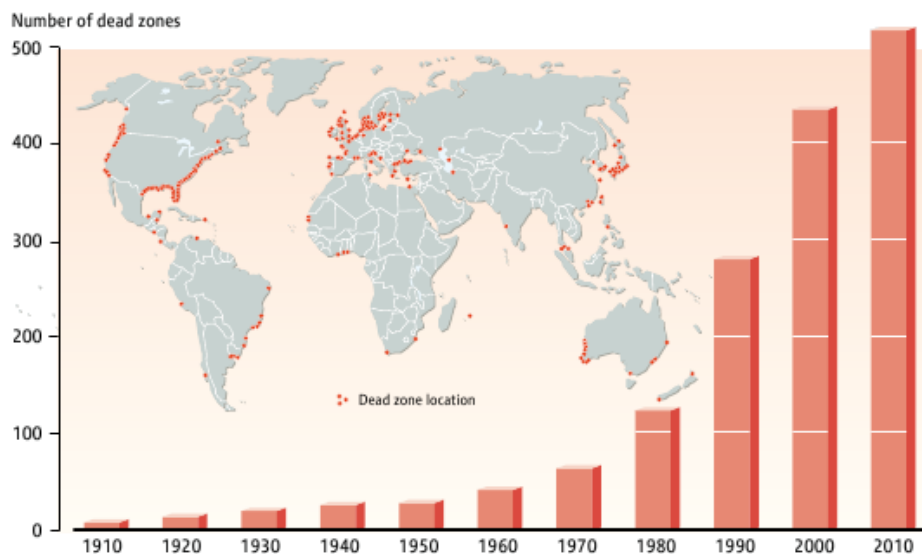
Fig. 2. Impact of some drivers of change to biodiversity loss

Traditionally, agricultural systems evolved as part of the tradition, beliefs, native technologies and myths of small communities. People plant a variety of crops to ensure food supply throughout the year. Crop diversification promotes sustainable agriculture while encouraging agro-system resilience and providing health benefits (Romanelli et al, 2014). However, current local agricultural practices have become incorporated into the global economy with landowners focusing more on so-called “cash crops” or commodities for export. While evolving agricultural practices provide food security by ensuring enough supply anytime, ironically, agriculture also destroys the richness of choices for good health and nutrition. There is a narrowing array of food sources from which we can derive micro- and macronutrients to ensure good nutrition and a healthy population. Of the 7,000 crops used as food by humans throughout history, currently only 12 crops and 5 animals provide more than 75% of human energy intake with 3 (maize, rice and wheat) providing more than 50% of caloric intake from plants (<https://www.cbd.int/health/SOK-biodiversity-en.pdf>.) Large plantations to make room for greater food production result not only in deforestation of large tracts of land but also oversimplification of food sources since only one or a few types of crops are planted.

The conversion of land to agricultural plantations results in huge losses to the wildlife and biodiversity of the area due not only to habitat loss from the clearing of forests but also to a dramatic shift in the nature of the ecosystem and the introduction of synthetics such as fertilizers and pesticides that has also led to rapid decline in the population of pollinators and the microbial biota necessary for nitrogen sequestering by plants. The same is true for aquaculture, that is, farming of the seas through fishponds and fish pens.

Introduction of single varieties and cropping patterns can thus affect biodiversity while farming results in habitat simplification, or species loss. Moreover, the crops or species being farmed are fed with fertilizers and unnatural feeds that can alter the nutritional content of these food sources compared with those found in the wild, making communities vulnerable to ill health. The rise of allergies from “farmed” animals and fishes are being attributed to these synthetic diets and other manipulations conducted or introduced to these animals to ensure increased productivity and “food security”.

Both agriculture and aquaculture while supplying enough food and fish for a growing human population are also causing the build up of dead zones (fig. 3) where oxygen have considerably dropped to levels that can no longer sustain life. Fertilizers and pesticides, intended to ensure food security are washed into waterways; undigested food from aquaculture also contribute to the buildup of nutrients and phosphates that promote algal growth. Decomposition of these nutrients and dead algae depletes water of oxygen contributing to dead zones and threatening food sources.



From Diaz and Rosenberg (2008). Science. Graph compiled by [Secretariat of the Convention on Biological Diversity \(2010\) Global Biodiversity Outlook 3, May 2010](#), p.60

Fig. 3. Growth of dead zones over 100 years (1910-2010) and locations in countries worldwide.

However, the decline in marine biodiversity is not only due to the build up of dead zones. In 2010, the UN’s 3<sup>rd</sup> Global Biodiversity Outlook (<http://www.who.int/globalchange/ecosystems/biodiversity/en/>) reported that 80% of the world’s marine fish stocks are depleted owing to overfishing in the open seas. Other aquatic animals such as marine mammals, birds and other animals such as polar bears dependent on the sea for food are also dwindling due to both anthropometric causes and global warming. A collapse of ecosystems supported by the oceans that comprise 75% of the earth could lead to collapse of other

ecosystems, including those found inland threatening human's very own existence. Excessive or non-sustainable utilization of ecosystem services will also compromise the future availability of these services affecting communities that depend on them.

The impact on the provisioning services of marine ecosystems in the Philippines is evident in many areas, particularly coastal sites. For example, a scenario in Bago Aplaya, where they used to fish; "the area was once a haven of marine resources in Davao City. But in one particularly noon recently, the elder Estrera already docked his banca with no catch even though he started out fishing since dawn. "It's not only now, several times, we went home without fish," he lamented" (Tacio, Nov. 2011 from PBSAP, 2015-2028). This scenario is repeated throughout the country.

Global warming, biodiversity loses and an increasing shift in nutrient distribution in the soils and waters as a result of the introduction of fertilizers and other synthetics (e.g. antibiotics) will eventually affect all food supplies in the years to come. Already global warming and biodiversity losses is showing evidences (Harvell, *et al.*, 2002) of the asynchrony of bird migration, mating and rearing with the arrival of food sources such as insects and seeds; plant pollination and arrival of cross-pollinators, etc. Populations of some insects, birds and predators are also declining due to consumption of food treated with pesticides or carcasses of animals that had consumed antibiotics or other synthetics. The decrease in the population of predators and preys will have a domino effect on the food chain. And thus, such disruptions in ecosystem interactions provided by a biodiverse population of living systems could adversely affect the provisioning services that such ecosystem provides.

### *How are the provisioning services of the ecosystem affected by drivers of change in the Philippines?*

The Philippines is a megadiverse country. It's unique archipelagic character, the abundance of active volcanoes and regular passage of storms contribute to the richness of the land and its water systems. Because of the presence of many island ecosystems, it has many unique flora and fauna while its coral diversity harbors a variety of marine life including fishes and other invertebrates making it the global center of coastal marine biodiversity. Being a megadiverse country, it has in the past provided food, clean water and other provisioning services for its population. However, over the last century, the rate of biodiversity loss is considered shocking, with many birds, fishes and small mammals placed under endangered or critically endangered species. Such loss is being attributed to the runaway population growth and its demands on ecosystem services, and extractive practices/ industries that have placed a stress on the provisioning services of the ecosystem. Currently, the build up of artificial islands is altering marine biodiversity in the West Philippine sea. Thus it is now one of the countries considered a biodiversity hotspot and many areas are classified as extremely urgent or critical for conservation.



## Assessments/ Activities (Allotted time: 60 minutes)

Looking at the Philippine scenario – the rise of fast food chains, the rapid loss of biodiversity, the population growth and many other drivers of change, answer the following questions:

1. Research on the physical environment of your community, as an ecosystem (e.g. birthplace, residence, etc.) several decades ago. What were the provisioning services the community obtained from their environment? What were the drivers of change that resulted in the community you have now. **G1**
2. Make a forecast of the impact of the drivers of change to the provisioning services of the same community (short term, i.e. 3 years; medium term or 10 years and long term or 25 years and beyond). (Note: Choose only one driver of change (It is better if in a class, there is a mix of marine or terrestrial ecosystem) and explain how it will impact on the provisioning services of this ecosystem. **G1**
3. What are obesogens? How did it evolve as part of the human diet? **G1**
4. How does livestock production for meat contribute to climate change? Explain briefly. **G2**

Optional activities (for teachers to do as alternative activities):

1. Observe your community. What resources do they get from their environment? How are these resources utilized? **G2**
2. Talk to an elderly in your community. Describe the environment when they were younger. What changes have taken place? How did it affect ecosystem services? **G2**
3. Describe or design a research on how bioindicators can be used to monitor soil, air and water quality. **G2**

## References

1. Executive Summary, Chapters 2, 5 and 6 in *Connecting Global Priorities: Biodiversity and Human Health. A State of Knowledge Review*.  
<https://www.cbd.int/health/SOK-biodiversity-en.pdf>.
2. Harvell CD, Mitchell CE, Ward JR, Altizen S, Dobson AP, Ostfeld RS and Samuel MD. 2002. "Climate warming and disease risks for terrestrial and marine biota". *Science* 296, 2158-2162
3. [http://www.bmb.gov.ph/downloads/ActionPlan/nbsap\\_pp1to109.pdf](http://www.bmb.gov.ph/downloads/ActionPlan/nbsap_pp1to109.pdf)
4. <http://server2.denr.gov.ph/uploads/rmdd/dao-2016-12.pdf>
5. Remans, R. and Smukler, S. (2013) Linking biodiversity and nutrition in: Fanzo, J. and Hunter, D. Borelli, T. and Mattei, F. (eds) "Diversifying Food and Diets: Using Agricultural Biodiversity to Improve Nutrition and Health. Issues in Agricultural Biodiversity", *Earthscan*, UK
6. Slingenberg A, Braat L., van der Windt H, Rademaekers K, Eichler L, Turner K. 2009. Study on understanding the causes of biodiversity loss and the policy assessment framework. Final Report.

7. Smith, Clare. 2017. <https://sciencing.com/degradation-ecosystem-philippines-23752.html>

### III. Ecosystem services 2: Regulating services that impacts on health

Before coming to class read “Ecosystems and Human Well-being: Health Synthesis” (p. 1-8) and Chapter 14 “Human Health: Ecosystem Regulation of Infectious Diseases” in the *Millennium Ecosystem Assessment 2005* <http://pdf.wri.org/ecosystems.pdf> and Chapters 7-8, (p. 130-163) and 10 (p. 170-179) of the review entitled, *Connecting Global Priorities: Biodiversity and Human Health. A State of Knowledge Review* (<https://www.cbd.int/health/SOK-biodiversity-en.pdf>).

1. Based on what you understood from your readings, what plausible mechanism related to disruption of the regulating services can you propose led to emergence and re-emergence of certain infectious diseases? Other diseases?
2. What could be the scenario for health beyond the 21<sup>st</sup> century if biodiversity loss and disruption of ecosystem services continues?

*How is a healthy ecosystem able to regulate and control diseases or contribute to wellness?*

Regulating services are ecosystem services that ensure quality of air, water and soil and controls diseases and risks, including environmental hazards. For example, a healthy ecosystem maintains the balance of species populations in an ecosystem ensuring that risks of overpopulation are minimized. Various organisms are contained in different niches and interactions with each other ensure that the population of these organisms does not go beyond the carrying capacity of the ecosystem. Thus vectors are kept in their habitats in numbers that are controlled through “dilution” or through the predator-prey interactions. It is also important for ecosystems to maintain its genetic diversity as this provides gene pools from which speciation can arise to enable species to adapt to changing environments or risks of predation and extinction.

Other regulating services include those that impact on the physical environment such as the presence of species such as mangroves that allows coastal areas to withstand flooding and storm surges during typhoons while wetlands and soil microbiomes ensure that wastes produced by living systems are treated and contained so that it does not put communities and the ecosystem at risk for contamination and ill health.

Global, regional and national assessments including the Millennium Ecosystem Assessment ([http://pdf.wri.org/ecosystems\\_human\\_wellbeing.pdf](http://pdf.wri.org/ecosystems_human_wellbeing.pdf)) stated clearly

that human health is influenced by the health of the ecosystem, including the plants and animals in it that they interact with. The health of communities is largely defined by interactions between people and their bio-diverse environment. A degraded ecosystem will be unable to mitigate the impacts of pollution, climate change, water scarcity and diseases, among others.

Nature has also provided man and animals with plants and other natural sources that can help heal ailments (<https://www.cbd.int/health/SOK-biodiversity-en.pdf> - Chapter 9). Thus ecosystems are sources of traditional medicine and raw materials for pharmacologic researches. Various natural products had been developed as sources of medicine. In 1997, ten of the widely used drugs in the market were derived from natural sources (<http://www.scidev.net/global/biodiversity/feature/biodiversity-facts-and-figures-1.html>). These included antibiotics, treatment for degenerative diseases including diabetes and anticancer therapeutics, as well. In addition, WHO estimates that about 80% of people from developing countries depends on traditional medicine for maintenance of health and treatment of diseases. In 2003, the Department of Health, Philippines released the names of 10 medicinal plants recommended safe as herbal preparations. <http://kalusugan.ph/sampung-halamang-gamot-ayon-sa-doh/> and these are currently being sold as extracts or pills used to treat various ailments.

Every ecosystem maintains a balance of species living within it including production of allelochemicals to regulate growth of plants and ward off herbivores within the ecosystem. Plants also produce secondary metabolites that attract or discourage herbivores or provide relief for ailments afflicting animals including man. Microbial diversity and a balanced ecosystem within the intestinal gut are essential for maintenance of health. A current review (Sandifer et al, 2015) point to a growing literature on the correlation between microbial diversity brought about also by dietary diversity as essential to improving health particularly in the reduction of allergies and other inflammatory diseases.

However, biodiversity losses have accelerated at the turn of the century. These rapid losses are attributable to many factors with climate change and global warming as the most important drivers. Nonetheless, global warming had its roots in the massive deforestation and the burning of fossil fuel, which add greenhouse gases into the atmosphere exacerbating the rise in global temperatures. A study commissioned by the US Congress in 2010 showed that biodiversity loss, specifically deforestation, contributes 17% of greenhouse gases emissions and the rise in global temperatures.

*Why and how would the extinction of keystone species result in the possible collapse of an ecosystem?*

Deforestation is the clearing of forests by cutting trees for wood or timber and to make way to plantations and agricultural zones or urban development. The consequences of deforestation are the following:

1. Loss of species that are highly specialized in microhabitats within the forests.
2. Loss of other species dependent or interacting with species that have become extinct (the “knock-on” effect), particularly in forest edges and fragments left by deforestation thereby further reducing biodiversity in the remaining forests. The extinction of keystone species can have a greater impact on the survival of other species since many of the latter depend on these keystone species to provide food, habitats, mating place, etc. or are essential to maintenance of balance in the ecosystem. A domino effect resulting from the loss of these keystone species will subsequently lead to the collapse of the ecosystem.
3. Loss of habitat of certain species, some of which are vectors able to harbor diseases, e.g. malaria and dengue, and their migration to human settlements. Vectors are insects or other organisms that transmit a pathogenic fungus, virus, or bacterium to other potential hosts.
4. Rise in CO<sub>2</sub> levels due to lower absorptive capacities of the forests, while enhanced decaying of organic matter left after the economically important parts are taken, and thawing of permafrost as well, further increase the levels of other green house gases such as methane; additionally diminished forests results in reduction of oxygen-producing benefits from the trees.
5. Loss of biodiversity results in reduction in ecosystem services (nutritional food, clean water, etc.) that sustains life, including human lives
6. Loss of chemical entities and genetic diversities that have the potential to cure ailments and health problems.

Another major driver to biodiversity loss is urbanization that was an offshoot of industrialization. Industrialization had and continues to have the following consequences: a) ecological consequences such as increase in total carbon emission due to burning fuels, b) acceleration of technological change that require new energy sources such as oil and increase in consumption of electricity and emergence of the chemical industry that increases the level of pollutants in the ecosystem; c) socio-economic impact marked by market capitalism and strengthening of the system of manufacturing and induced massive urbanization resulting from mechanization of agriculture and population explosion.

### A probable reason for the emergence and re-emergence of certain diseases

WHO defines health as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity”. The current change in global temperatures or global warming has caused the emergence of new and re-emergence of previously-controlled diseases. The warming temperatures accompanied by increased rainfall and alternating bouts of drought and flooding provided an environment conducive to growth of microorganisms. This coupled with increased pollution brought about by industrialization and a large population particularly in cities and poor sanitation in remote areas favors the growth and mutation or transformation of many microorganisms. Cholera, caused by the bacterium, *Vibrio cholera* is transmitted primarily by contaminated drinking water and food (<http://www.who.int/globalchange/climate/summary/en/index5.html>) and is a major cause of death in developing countries where clean water is lacking or clean water is contaminated due to flooding.

Climate change, deforestation and encroachment by a ballooning human population, has also affected migration patterns of birds and host transmission patterns such that birds, rodents and insects that are infected can move from natural habitats to open areas including human settlements, infecting other vertebrates and humans as well. In the Philippines, the incidence of leptospirosis has increased due to increased rodent population, exacerbated by flooding that dissolves infected urine affecting more people. The increased rodent population coincided with the decrease in the population of its predators (snakes, birds, etc.) that have lost their forest habitats or are predated also by humans. The increasing temperature (see Fig. 4 & 5) that has seen an increased in the maximum and minimum temperatures by 0.36°C and 1.0°C, respectively in the last 60 years, has also enhanced the survival, and reproduction rate of vectors such as mosquitoes and other insects. Anopheles mosquitoes transmit malaria while dengue is transmitted by various species (> 130 species) of mosquitoes worldwide. Researchers found that the incidence of dengue fever increased 2.6 percent every week for every 1 degree Celsius increase in temperature starting at 20°C and peaking at 32°C. In addition it was also determined that there was a 1.9 percent increase in dengue cases with every centimeter increase in weekly precipitation ([http://ete.cet.edu/gcc/?/humanhealth\\_disease](http://ete.cet.edu/gcc/?/humanhealth_disease); <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3828158/pdf/pntd.0002503.pdf>).

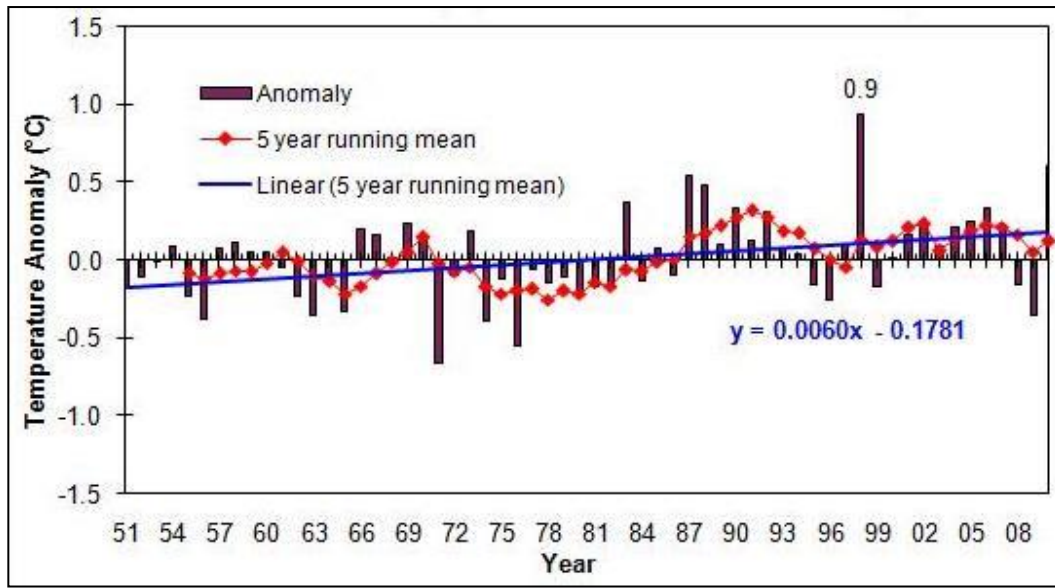


Fig. 4. Observed mean annual maximum temperature anomalies in the Philippines during the 1951-2010 period. The observed maximum temperature has risen by 0.36°C over the 60-year period. (Source: PAGASA report entitled, “Climate change in the Philippines”, Feb. 2011).

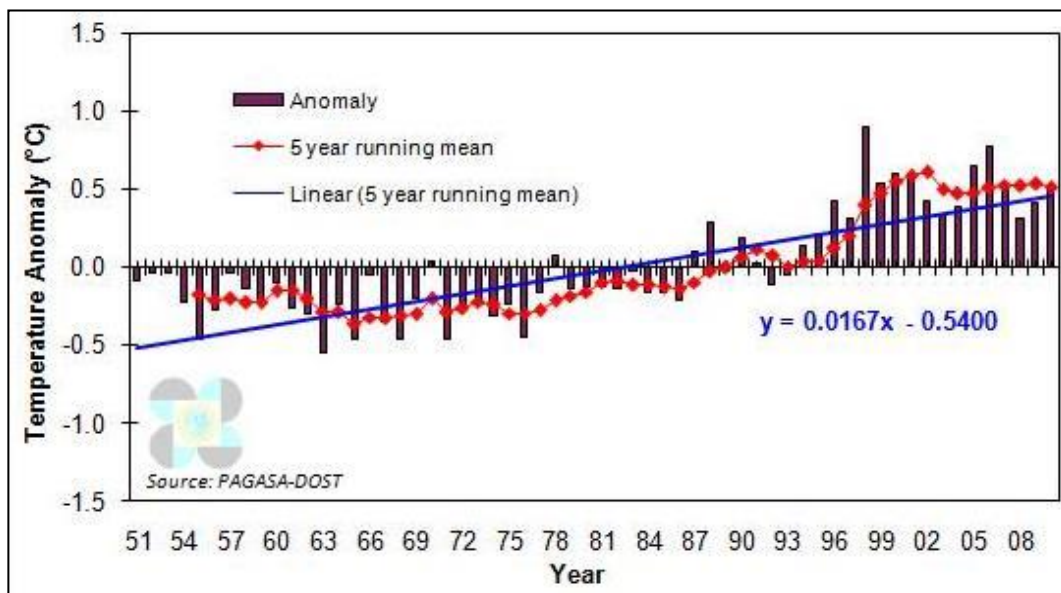


Fig. 5. Observed mean annual minimum temperature anomalies in the Philippines during the 1951-2010 period. The observed minimum temperature has risen by 1.0°C over the 60-year period. (Source: PAGASA report entitled, “Climate change in the Philippines”, Feb. 2011).

We are now seeing diseases caused by microorganisms, animals, and insects in regions where these diseases weren't reported before. The vectors - insects,

rodents, or other animals that carry the diseases could never have survived in these regions before the climate change. The warmer temperatures allow these vectors to thrive and proliferate, carrying the diseases with them. Droughts combined with bouts of heavy precipitation favor population explosions of disease-causing organisms. The world's poor and children are most affected. In the last several years, more than 90 percent of malaria and diarrhea deaths occur in children 5 years or younger.

There is also the growing threat to modifications of biodiversity, particularly microbial biodiversity because of the release of active pharmaceutical ingredients (API) produced by pharmaceutical companies or thrown in wastes by ordinary citizens. These substances have been detected in bodies of water worldwide. An alteration of microbial biodiversity resulting in resistant or mutant organisms with altered characteristics as well as direct effect of exposure to these pharmaceuticals present in water can have negative consequences for human health. Already we are seeing the emergence of new diseases and the re-emergence of diseases previously thought to be controlled, but are currently showing resistance to known antibiotics against these diseases. These include methicillin-resistant *Staphylococcus aureus* (MRSA), multi-drug and extremely drug-resistant tuberculosis (MDR-TB; XDR-TB), and other resistant pneumonias, etc. The rise in immune disorders and allergies are also thought to be some consequences of direct exposure of humans to these active ingredients. The extensive use of pesticides and synthetics has also increased the transformation of soil organisms and the incidence of cancer and cancer-related diseases in both humans and animals.

The rise in global temperatures has caused a variety of health problems. In the last decade, diseases that were otherwise dormant or were controllable by various means are now on the rise with some occurring in epidemic proportions. In the Philippines, various health problems include dengue where overall, cases have risen; tuberculosis that have also seen the rise of resistant ones, and other infectious diseases, e.g. avian flu that have jumped through the species barriers as well as degenerative disorders including cancers. Unfortunately it is the poor, women, children and the elderly that is most vulnerable to the impact of the drivers of change to the regulating services derived from healthy ecosystems.

### **Assessments/ Activities (Allotted Time: 60 minutes)**

1. Analyze the data for your regions given in Tables 1, 2 in the Appendix provided (Reported cases of Dengue, Leptospirosis and Malaria - DOH). Identify trends for the diseases provided. **G3**
2. What hypothesis can you formulate out of the data presented with regards to the incidence of the disease and the trends in precipitation and temperature data in your regions? (Figs 4-5 (this text) **G3**
3. How can you test the hypothesis? What factors need to be studied further to test the hypothesis? **G3**

## References

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2. Colon-Gonzales FJ, Fezzi C, Lake IR and Hunte PR. (2013). "The Effects of Weather and Climate Change on Dengue". *PLOS Neglected Tropical Diseases* 7 (11), e2503.  
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3828158/pdf/pntd.0002503.pdf>
3. Chapters 7-10 of the review entitled, *Connecting Global Priorities: Biodiversity and Human Health. A State of Knowledge Review*.  
<https://www.cbd.int/health/SOK-biodiversity-en.pdf>
4. Ecosystems and Human Well-being: Health Synthesis (p. 1-8) and Chapter 14 "Human Health Ecosystem Regulation of Infectious Diseases" in the *Millennium Ecosystem Assessment 2005*:  
[http://pdf.wri.org/ecosystems\\_human\\_wellbeing.pdf](http://pdf.wri.org/ecosystems_human_wellbeing.pdf)
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#### IV. Ecosystem services 3: Aesthetic and cultural services and its impact on physical and mental health

Before coming to class, read the article by Clark, et al. "Biodiversity, cultural pathways and human health: a framework". *Trends in Ecology & Evolution*. 29 (4), 198-204. [http:// dx.doi.org/10.1016/j.tree.2014.01.009](http://dx.doi.org/10.1016/j.tree.2014.01.009). and p. 457-472 of Chapter 17: "Cultural and Amenity Services" in the *Millennium Ecosystem Assessment 2005* or Chapter 12: "Contribution of Biodiversity and Green Spaces to Mental and Physical Fitness and Cultural Dimensions of Health" in the review entitled, *Connecting Global Priorities: Biodiversity and Human Health. A State of Knowledge Review* (p. 200-220).

1. Trace how culture evolves in relation to the community's environment.
2. How does the environment influence the psychological and social behavior of people in the community?
3. Research on a local literature, traditions and rituals or dances and songs that describe nature or how the community related with living systems (to be done outside the classroom). How did the work treated and celebrated



nature and the environment? What is the status of these literature, traditions, or rituals and songs?

*What non-tangible benefits can we get from nature?*

The non-material or intangible benefit one obtains from the ecosystem that contributes to overall wellness is called “cultural” services. The presence of various organisms in a bio-diverse ecosystem creates a plethora of effects ranging from releasing a variety of sounds and smells, or a breathtaking display of colors in various hues and intensity. These natural displays have continued to awe humans and their communities which considers their societies to be part of nature. That oneness creates a unique culture for every community enabling them to weave their beliefs, traditions, practices, languages, art, songs, literature and myths with the ecosystem they are part of.

Love for nature begins in early childhood. A child awed by nature because of his/her exposure or awareness of the living systems in the environment during his/her developmental state will develop that love for nature and perhaps actively play a role in conserving the ecosystem.

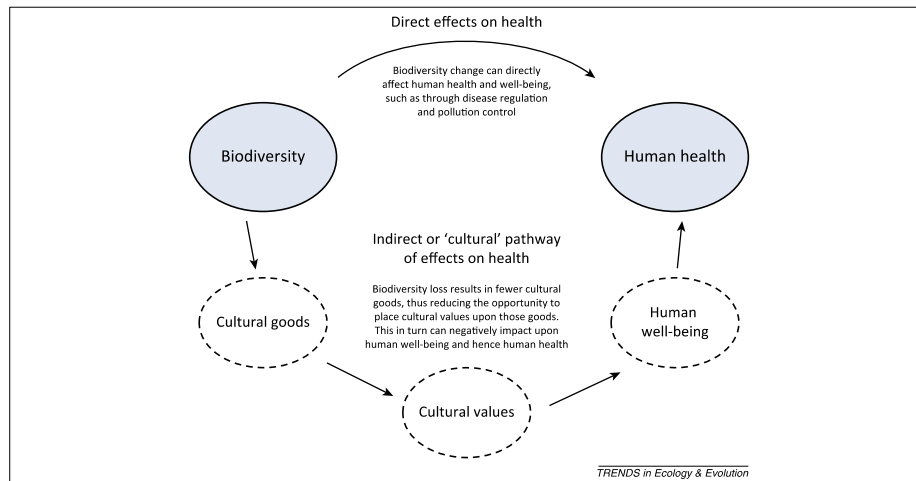
A biodiverse environment or an environment that provides green spaces can provide both physical and mental benefits. Access to the natural world provides a green space to do physical activity that is essential to good health and wellness, lessen risks of non-communicable diseases such as diabetes, and extend life expectancy. It has also been attributed to increased immune function essential to combat communicable diseases. In addition, exposure to other microorganisms in the environment may help keep harmful organisms at bay. Communing with nature provides humans a clear mental state; studies have shown that exposure to the natural world decreases depression, anxiety and stress. Worldwide, depression accounts for 4.3% of the burden of mental health particularly afflicting women. Studies have shown that those exposed to a green and biodiverse environment showed fewer symptoms of mental problems including depression, than those who were not exposed. Other researches have also shown increased recuperation time for patients exposed to an experience with nature, whether virtual or real.

Opportunities for tourism and recreation are other benefits we can derive from a healthy ecosystem. More than half of the world’s population lives in cities or the so-called “cement” jungle. Thus those from urban communities, particularly those that are too busy with work, take a break by travelling to various places as tourists, many to experience living with nature to relax or de-stress. However, while some exclusive housing zones created green spaces within their communities, many others live in poor, crowded communities devoid of interactions with nature. Such interactions with nature are also seen to be reduced in children in developed countries that are focused on scholastic excellence, decreased outdoor activities, increased use of technology and

parental fear for child safety. The rise in psychological problems, stress and anxiety and poor coping mechanisms for children and young adults are being associated with a decreased “cultural” experience with nature. The current health problems modern societies are facing are mostly lifestyle diseases associated with intake of unnatural foods, a sedentary life and the lack of mental relaxation.

How does biodiversity loss contribute to the rise in non-communicable diseases, mental and psychological health problems?

Several studies have shown the contribution of green spaces to psychological, physiological and endocrinal health. The rise of non-communicable diseases such as diabetes has been attributed not just to consumption of high fat from production-intensive animal sources but also to the loss of green spaces and the opportunities for recreation and exercise. Thus the changes that our environment had undergone resulting in huge biodiversity losses can also have detrimental impact on mental and endocrinal health of humans and that of the communities, in general. Thus, not only will physical health be affected but also social and mental health as well as community cohesion. The indirect relationship of “cultural services” to health and wellness is shown by the figure (6) below.



**Figure 1.** The direct and indirect (cultural) pathways from biodiversity to human health. Biodiversity change can directly affect human health, such as through the regulation of the emergence and transmission of diseases, or via pollution control. We propose that biodiversity change can also indirectly impact upon human health via cultural pathways; biodiversity loss affects the provision of cultural goods, which reduces our opportunity to realise the cultural value placed upon those goods and, consequently, negatively impacts upon human well-being and, therefore, health.

Fig. 6: Indirect relationship of “cultural services” as an ecosystem service, to health and wellness (Source: Clark et al, 2014).

The Philippine population is growing rapidly averaging 1.73% annually (<https://psa.gov.ph/sites/default/files/attachments/hsd/pressrelease/Highlights%20of%20the%202010%20Census-Based%20Population%20Projections.pdf>).

Even if the growth slows down to 0.65%, by 2045, we would have grown to 142 M with population concentrated in several urban centers. The runaway population growth has produced various stresses on the environment with the

Philippines as the country that has experienced the highest biodiversity loss in this century. Most urban centers are cities that have lost their green space to become informal dwellings for people who have migrated to these places in search of livelihood opportunities and/or political persuasion. The conversion of lands has continued unabated and also because of urban migration our local traditions and indigenous cultures are fast disappearing.

### **Assessments/ Activities (Allotted Time: 60 mins)**

1. Given a green building/environment, what interactions of living systems are evident? What are the biological interactions being simulated in the green design? **G4**
2. Do any one of the following: 1) create music out of sounds you hear from nature; 2) create artwork (digital, performing or visual) from patterns you see in nature; 3) go to a field and observe the various living things (except humans) and the ecosystem you find them. Describe how you felt. **G4**

Additional activity (optional):

3. Suggest ways or policy recommendations to preserve the ecosystem's cultural services. **G4**

### **References**

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