Title of the Paper: Providing Conservation as “*Title-To-Conservation*” Under IMACS

Author Names: Vincent Dert

Affiliations: Founder of Sustain One World – LLC

Abstract: In order to prevent the devastating effects of global warming on biodiversity and in turn on humanity, CO_2 emissions and other forms of environmental damage must be all but eliminated, while environmental protection and restoration must be applied on increasingly larger scales. The methods described here are used under the IMAC system and create both the vehicles and the incentives to provide very large amount of funding to finance all types of conservation, needed to attract industry to make the needed carbon sequestration investments and to create financial incentives for the various other types of environmental conservations needed. As an essential element of the Environmental Impact Measurement and Conservation System (IMACS), the “*Title-To-Conservation”* (TTC), allows not only a relatively fast reduction of net CO_2 emissions, but a potential fast return to pre-industrial atmospheric conditions, while minimizing biodiversity losses. TTC represents the purchase and application of conservation in the name of the applying individual and is used to offset the exact amounts of environmental damage created by the product or service purchased. After calculation of the impacts of products and services, the required amounts of TTC for each impact type are purchased automatically as a 2^{nd} purchase immediately following the primary purchase. After this 2^{nd} purchase, the product or service is free of damaging impacts. The use of TTC will create very large market demand for all types of environmental (E) and later humane condition (H) conservation purchased by customers. TTC will need to be made available in any fractional amount and for an increasing number of types of conservation. The costs of the purchased conservation are paid by the seller using electronic (E) vouchers. Since participating sellers only pay E-voucher costs for “participating” products purchased by “participating” end-user consumers, the seller’s costs are initially very low, but create a strong incentive to become carbon neutral and to prevent other damaging impacts, eliminating future EH-voucher costs. For a supply chain layer with 100% participating actors, the EH-vouchers are forwarded along the supply chain to the retailer, resulting in each actor paying only for the EH impact damage they themselves created. By installing carbon neutral systems and otherwise preventing EH damage, the corresponding cost of EH-vouchers for “current damage” can be reduced to zero. The resulting savings remain and benefit participating sellers and buyers and work towards a rapidly more sustainable society. By providing a financial penalty to EH-damages done, equal to the cost of restoration of natural resources and humane conditions, the method solves the almost two centuries old “Tragedy of the Commons” for which the concepts extend back to antiquity (Aristotle).

Keywords: Sustainability, Sustainable economy, biodiversity, protection, restoration, carbon neutrality, carbon negativity, Carbon capture engineering, Sustainability sciences, international protection of human rights

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Corresponding Author:
Name: Vincent Dert
Email: leedert@gmail.com
Twitter account: @vincentdert1

Providing Conservation as "*Title-To-Conservation*" Under IMACS

1. Abstract

In order to prevent the devastating effects of global warming on biodiversity and in turn on humanity, CO_2 emissions and other forms of environmental damage must be all but eliminated, while environmental protection and restoration must be applied on increasingly larger scales. The methods described here are used under the IMAC system *(1,2,3,4)* and create both the vehicles and the incentives to provide very large amount of funding to finance all types of conservation, needed to attract industry to make the needed carbon sequestration investments and to create financial incentives for the various other types of environmental conservations needed. As an essential element of the Environmental Impact Measurement and Conservation System (IMACS), the "*Title-To-Conservation"* (TTC), allows not only a relatively fast reduction of net CO_2 emissions, but a potential fast return to pre-industrial atmospheric conditions, while minimizing biodiversity losses. TTC represents the purchase and application of conservation in the name of the applying individual and is used to offset the exact amounts of environmental damage created by the product or service purchased. After calculation of the impacts of products and services, the required amounts of TTC for each impact type are purchased automatically as a 2nd purchase immediately following the primary purchase. After this 2nd purchase, the product or service is free of damaging impacts. The use of TTC will create very large market demand for all types of environmental (E) and later humane condition (H) conservation purchased by customers. TTC will need to be made available in any fractional amount and for an increasing number of types of conservation. The costs of the purchased conservation are paid by the seller using electronic (E) vouchers. Since participating sellers only pay E-voucher costs for "participating" products purchased by "participating" end-user consumers, the seller's costs are initially very low, but create a strong incentive to become carbon neutral and to prevent other damaging impacts, eliminating future EH-voucher costs. For a supply chain layer with 100% participating actors, the EH-vouchers are forwarded along the supply chain to the retailer, resulting in each actor paying only for the EH impact damage they themselves created. By installing carbon neutral systems and otherwise preventing EH damage, the corresponding cost of EH-vouchers for "current damage" can be reduced to zero. The resulting savings remain and benefit participating sellers and buyers and work towards a rapidly more sustainable society. By providing a financial penalty to EH-damages done, equal to the cost of restoration of natural resources and humane conditions, the method solves the almost two centuries old "Tragedy of the Commons" *(5)* for which the concepts extend back to antiquity (Aristotle).

2. Introduction

In order for humanity to live sustainable, environmental conservation must be applied on large scales specially to reduce atmospheric carbon dioxide concentrations, to adequately protect biodiversity and to eliminate water scarcity. Current methods do not offer adequate options to calculate E-impacts of products and services sold and do not offer options to apply adequate amounts and types of environmental (E) conservation during the purchasing process *(6,7).* Under IMACS, the per capita available amounts of natural resources can be calculated (the "allowance"). To live sustainably with respect to natural resource usage, no more than the allowance can be used *(7,8)* while a certain fraction (the "*presumptive ratio*") of the resource must be protected) *(8,9).* This applies to usage of cultivated land area, cultivated marine areas and water and soil usage. No allowance exists for current E-damage impacts (wildlife area destruction or damage, CO2 emissions, pollution and resource use exceeding allowances); all damage done must be restored. Participation is voluntary. Participants can be organizations or individuals. Increases in participation will be gradual and are envisioned to reach 100% of the rich world population in ~ 20 years. E-impacts for E-resources used, E-damage done and their required amounts and types of E-conservation can be calculated *(10)* for all participating products and services. Immediately following the electronic purchase, the required amount of conservation is purchased automatically as a 2nd purchase (limited by the availability of conservation), paid for with the E-voucher provided by the seller. However, no methods exist to buy and apply such fractional E-conservation.

3. Providing Conservation as "Title-To-Conservation" (TTC)

3.1. Goals and Objectives

The Environmental Impact Measurement and Conservation System (IMACS) aims to measure the environmental (E) impacts and apply environmental (E) conservation to neutralize current damage and restore damage done in the past (historic damage) to pre-industrial conditions *(7).* The question can be asked as to how much environmental restoration is needed, since each Ha of cultivated area restored to biodiverse wildlife area is no longer available for cultivated uses. A stark reduction in global cultivated area in use will reduce the per capita "space" available to grow crops and produce meat (especially beef and mutton). While this would appear as a reduction in space available per capita, the per capita space used already exceeds sustainable levels and will lead to an environmental collapse and likely a collapse of civilized societies *(11).* The current area in cultivated use does not include the additional areas needed to lift the poor out of poverty. Ultimately, in addition to other changes towards sustainability, the world population needs to drop to allow humans to live sustainably on Earth. For any challenging goal (especially when set close to thermodynamic or natural limits), it is typically difficult to actually reach the exact numerically stated goal. Rather than moving the goal posts to more easily reachable positions, it is better to set challenging goals to their technical limits and try to reach them as good and as fast as possible. The goal is therefore set to reach "perpetual sustainable conditions"!

> *In order to return to perpetual sustainable conditions, the current E-damage done on a daily basis must be stopped ASAP, pre-industrial atmospheric conditions must be restored and sufficient wildlife area must be restored to reduce the rate of species extinctions to the background rate prior to the human existence.*

Pre-human extinction rates were not constant; some genera and some geographic locations were much more vulnerable to extinctions than others. The average pre-human extinction rates were smaller than the average pre-human diversification rates. Biodiversity was on average increasing. Current extinction rates are about 1,000 times higher than natural background rates of extinction and future rates are likely to be 10,000 times higher *(12).*
E-impacts are created on (in or above) terrestrial and marine areas and are assigned to the products and services produced using such areas. E-impacts can be natural resource use, E-damaging or E-conserving (protection and restoration). Three overall process options can be defined to increase sustainability:

A. Sustainability improvement by:
   a. continual reduction of current damage leading to its (essential) elimination
   b. reduction of natural resource use in excess of allowances (to below max sustainable values)
   c. applying 100% conservation of natural resources
   d. applying 100% restoration of historic damage
B. Sustainability improvement by:
   a. applying 100% conservation of natural resources while maintaining excessive resource use
   b. applying 100% restoration of historic damage while maintaining current damage
C. Sustainability "improvements" without meeting sustainability requirements (the current process used)

Under option C, the world is racing to an increasingly lower overall sustainability and to environmental disaster. Option A is a combination of preventive and net restorative measures, while option B are only corrective measures not leading to improvements and thus leading to continual deterioration. In essentially all cases, preventive measures under A represent lower costs than corrective measures under options B or C.
All processes under option A are needed to allow a return to pre-industrial environmental conditions. Since preventive measures represent lower cost and have less or no capacity limits, preventive measures should be selected preferentially. We cannot switch overnight from the current option C to option A (we need to build the required conservation capacity over time) and option B will need to be applied while option A is not sufficiently available.

3.2. Current Versus Required Conservation

In order to return to perpetual sustainable conditions, the current E-damage done on a daily basis must be stopped, pre-industrial atmospheric conditions must be restored and sufficient wildlife area must be restored to reduce the rate of extinctions to the background rate prior to the human existence. This requires a large change in conservation practices. The main types of conservation that currently exist are wildlife area conservation, drinking water source conservation, carbon sequestration as standing forests and protection of lands against flooding.

Drinking water is often extracted from areas where limitations are set for discharge of certain pollutants to surface or ground water. With respect to discharge of pollutants, such areas are "protected". However, the list of pollutants can be too limited, enforcement can be lackluster, while protection is typically limited to water quality aspects and almost never includes the protection of the amounts of fresh water that remains available to nature. Excessive extraction lowers the water table, dries out wetlands at higher elevation which then lose their specific biodiversity and can be a major cause for forest fires for all areas. Under natural conditions, precipitation makes its way through the watershed supporting natural system with a certain amount of evapotranspiration. Humans can quantitatively use and recycle water resulting in a net zero consumption of water compared to its natural flow, but this does not apply to water evapotranspiration for crop irrigation, golf courses and gardens. Richter *et al*, proposed the use of a "*presumptive standard"* for environmental fresh water flow protection *(9).* Prior to detailed studies, about 10% of the water of a stream or river can safely be extracted without causing biodiversity damage. Under IMACS, any anthropogenic water consumption in excess of such safe water extraction standards, is considered E-damage. In many areas water extraction is many times this safe extraction limit. Some rivers no longer run off to sea (Colorado river) destroying their transitional brackish water habitats and preventing salt water fish to spawn in their upstream tributaries. All wastewater should be purified in biological waste treatments systems to prevent surface or groundwater pollution. In most cases such treated water is pumped out to rivers or directly to sea. To maintain the natural water flow through the watershed, biologically purified water should either be returned to injection points around the extraction source location, or pumped to higher elevations for areas suffering anthropogenic water stress. The cost of doing so is much lower than returning the same amount as reverse osmosis water to the source location. Ground water aquafers need to be replenished over time to their original pre-industrial levels. Fresh water conservation organizations need to be created to conserve a biodiversity safe fresh water flow through all global watersheds, by limiting fresh water withdrawals and anthropogenic evapotranspiration, by returning purified water to withdrawal locations, by pumping clean fresh water to aquifers, by maintaining environmentally safe levels of water runoff to sea (river and hyporheic flows) and by providing reverse osmosis water as the balance needed for all global terrestrial eco-regions. For every liter of fresh water extracted and "consumed" (not quantitatively returned to its source) from a flow section, a typically much larger amount of water, meeting the presumptive or actually studied ratio R_{Aqua}, should be conserved within the same flow section, such that the presumptive ratio R_{Aqua} is met.

Wildlife area conservation is typically funded by governments or charities. While a sizable fraction of global lands and coastal marine areas are officially protected, the protection is not always focused on biodiversity conservation (e.g. many state and national parks), while many organizations protecting wildlife areas have insufficient funds to adequately protect the areas under their care, to expand them where needed or to create protected wildlife corridors between nearby protected wildlife areas. Many wildlife areas are assigned a dual-use status, where protection for biodiversity and commercial use (typically farming and collection of forest products) are combined. While such a combination may provide adequate protection for biodiversity in some cases, biodiversity losses may continue in others. The fraction of both terrestrial and marine areas to be protected for their biodiversity should be based on the requirements to prevent all extinctions of both known and unknown species (the majority) *(13)* and should not be based on what is politically feasible in any particular country. Based on the extinction prevention criteria, the fraction of areas currently protected for their biodiversity likely requires a significant expansion. The presumptive standard developed for fresh water flows *(9)* can also be applied (in modified form) to the ratio of wildlife area that need to be protected over the cultivated area used in each eco-region. For every m^2 of cultivated area used for a product or service, a certain amount within the same eco-region needs to be protected for its biodiversity such that the presumptive (or actually studied) ratio R_{Bio} is met.

Some lands at risk of flooding are protected by dike system. Dike systems are on large scales used to protect low lying coastal lands and lands bordering rivers from flooding. Economic damages from floods are expected to increase with sea level rise induced by global warming. However, a 2017 study showed that "*global costs of flood damage in the year 2080 can actually be reduced to below the current (2017) level if we effectively invest in flood protection measures*" *(14).* Protection of cultivated coastal areas from flooding not only saves money, it also prevents humanity to move onto biodiverse wildlife areas after floodings and thus preserves biodiversity. In addition to protecting cultivated land from flooding to prevent financial losses, we need to protect the most biodiverse land at risk of flooding, in order to prevent biodiversity losses. The loss of (freshwater) biodiverse lands to salt water is as bad or worse for the original species assemblies compared to the "average" (non-salt water flood induced) landscape change. Once seawater floods lands, the salt is there to stay. Very few species living in fresh water soils can survive marine salt levels *(15).* Compared to the average landscape change, where remnants of the original species populations can still survive on or around rocky outcroppings, hedgerows, edges of the fields and along roads, salt water floodings are more effective in killing the original species populations. Ample expertise is available to build dike systems and there will be no shortage of companies to build such systems if enough funding is available.

Trees store carbon both above and below ground. Under natural atmospheric conditions, the soil carbon stored marginally increases with forest turnover until a steady state condition is reached. Under the current strongly elevated atmospheric carbon dioxide conditions, the remaining forests grow much faster. However, the amounts of CO_2 than can be stored in forests are much smaller than required to return the atmosphere to pre-industrial conditions. In addition, if humanity would manage to return the atmosphere to pre-industrial conditions, all carbon stored above the level corresponding to pre-industrial atmospheric conditions will over time be emitted as CO_2. While the increase in carbon stored is in that case temporary, the corresponding CO_2 is removed from the atmosphere during a critical period where no other systems are available to store carbon at scale. Carbon storage in trees is thus still valuable as a partial and temporary solution. Some organizations already claim such tree stored carbon dioxide, but no independent system exits to verify the amounts of carbon annually stored in and released from forests. Carbon sequestration from air and permanently stored in underground basaltic rock formations is currently started at a commercial scale. For every kg of CO_2 emitted for a product or service purchased, one kg of CO_2 must be sequestered to render the consumption sustainable. Carbon sequestration from air was developed over the last decades. A handful of pilot facilities was built and only recently commercial scale production facilities (≥ 1-million-ton CO_2/year) are under construction. The number of companies with intentions to build Direct Carbon Capture and Carbon Sequestration (DAC&CS) facilities is growing year over year. The construction of such facilities is currently limited by the almost non-existing market demand (no paying customers).

3.3. Conservation Organizations (ECOs and HCOs)

The various Environmental Conservation Organizations (ECOs) and Human Condition Conservation Organizations (HCOs) providing TTC will be:

- Nature Protectorate Organizations (NPOs) provide TTC for biodiversity conservation of Nature Protectorates (NPs) by effective protection and restoration of wildlife areas for their biodiversity.
- Carbon Sequestration Organizations (CSOs) providing TTC for protection of stored carbon (fossil fuels, soil carbon, forests, permafrost stored CO_2 and methane and for sequestration of carbon dioxide captured from air.
- Precipitation Area Protection Organizations (PAPOs) provide TTC for fresh water conservation by protection and restoration of watershed areas and their aquafers for water quality and amounts available to nature.
- Fresh water generating organizations based on reverse osmosis, providing fresh water for direct used by consumers or to offset excess fresh water use, while the water is pumped to storage (underground aquifers).
- Soil & Sediment Conservation Organizations (S&SCO) provide TTC for soil and sediment conservation.
- Coastal Flooding Protection Organizations (CFPO) provide TTC for coastal area protection against flooding of currently terrestrial areas and protection of shallow marine waters and marsh areas.
- Human conditions protection and rehabilitation organizations (HCPROs) providing TTC to protect humane conditions and to rehabilitate negatively affected individuals.

In order to sell or buy any form of conservation to be sold as TTC, organizations must be a IMACS participant, must be trained and certified by the IMACS organization, must monitor all relevant conditions and must be frequently audited by licensed IROs specialized in each type of conservation. In addition, organizations providing conservation must have financial reserves deposited in a Catastrophic Reserve Fund, sufficient to restore any damage done (burning, damaging or cultivating of wildlife areas, loss of sequestered CO_2 from storage, etc.). In case of insufficient financial reserves, a total loss insurance for the balance of the Catastrophic Reserve Fund is required, while most of the TTC receipts will be routed to an independent organization to build a total loss fund. The fraction of TTC funds paid out to the ECO will gradually increase with the increase towards the required capital amount of the Catastrophic Reserve Fund. All TTC made available and accredited by IROs to each participating conservation organization will be sold through a Sustainability Maintenance Organization (SMO). All organizations providing conservation still use cultivated area, emit greenhouse gasses and other pollutants, consume fresh water, may not provide sufficient protection against coastal flooding, and may not meet humane conditions for all employees. Except for the focus on conservation, TTC is a product as any other for which EH-impacts are expressed as a collection of EH impact variable values.

3.4. Conservation Fund Organizations (CFO)

"Title-To-Conservation" (TTC) will be sold in large amounts by Environmental Conservation Organizations (ECOs) providing the specific types of protection and/or restoration and are first purchased by *Conservation Fund Organizations* (*CFO*). The CFOs need to buy all types of conservation that are required to be applied at any given time. While this will start with one type of conservation, the number of types of conservation will increase over time. Since each product sold has different requirements for the amounts and types of conservation, different products sold require different packages of TTC. It is the function of the CFO to instantly provide the required mix of conservation as required for the product or service sold. CFOs can sell TTC for immediate or future delivery. The latter is based on long term contracts with conservation providing organizations, and can be done as long as the long-term delivery contracts are approved by the IMACS organization. This applies to C-sequestration and dike protection against marine floodings, where the businesses making the investments can more quickly line up investors when part or all of their production capacity for the first years is already sold prior to start of construction. In case of future delivery, the TTC funds received are stored in special Environmental Restoration Funds (ERFs) that can only be used for the specified type of E-restoration that was purchased by end-user consumers. Payout of TTC to the Environmental Conservation Organization will only take place upon delivery of the conservation. TTC can thus be purchased for immediate or future delivery, but is in both cases treated as "applied" by the end-user consumer who purchased it. For most other types of conservation, TTC is purchased for immediate delivery.

3.5. Title-To-Conservation (TTC)

For all participating products and services purchased by a participating end-user consumer, the required amounts and types of conservation will be purchased automatically in a 2nd transaction immediately following the primary transaction and will be paid for using the E-voucher made available by the seller. After this purchase, the buyer does not "own" the conservation applied (the CO_2 sequestered or the wildlife area conserved) but can claim that the conservation was applied in his or her name. In case of sequestration of 10 kg of CO_2 for a purchase of gasoline, the CO_2 is sequestered deep underground, while the buyer has "title to the application of the conservation". Prior to the purchase of the gasoline, the buyer has "title to emissions" of 10 kg of CO_2. After the purchase of conservation, the "Title-To-Conservation" of 10 kg of CO_2 neutralizes the "title-to-emissions". Since the amounts for the various required amounts of conservation vary with the product and can become very small for low-cost products, TTC for all types of conservation must be made available in any fractional amount and at the same unit costs, independent of size, similar to the purchase of fractional amounts of ETF (exchange traded fund) or mutual funds investment units.

3.6. Limited Availability of Conservation

While organizations providing E-conservation exist (e.g., for wildlife protection and carbon sequestration), currently no conservation is available as TTC. Existing conservation organizations need to first meet the required conditions in order to be certified as ECOs and issue TTC. The capacity to supply TTC will only gradually increase over time with increasing demand. While protection of existing wildlife areas can be set up relatively quickly, the restoration of wildlife areas from crop fields or plantations will take time. The initial pre-planting of native species on newly purchased agricultural lands can be done relatively quickly, but grazers can be introduced only after trees are sufficiently tall and the annual growth of foliage can sustain the native grazers. Large predators, required to keep the populations of grazers at sustainable levels, may need to be translocated from far away locations. To prevent extinctions, translocation to climatic suitable areas different than the original habitat may be needed *(16)*. Even if the original habitat area can be restored, under perfect management conditions it will take centuries for the wildlife area to reach the biodiversity resembling pre-industrial conditions. While the required surface area of wildlife area under restoration may be reached after a few decades, expressed in units of biodiversity, there will be a shortage for centuries. The same applies for carbon (C) sequestration; compared to the capacity required to return to pre-industrial conditions, the current capacity is essentially zero and will likely remain low for years. Even if C-sequestration facilities were built at breakneck speeds, the C-sequestration capacity will be in short supply for decades (likely 30 to 40 years). Once the atmosphere returns to pre-industrial conditions, it will take centuries to millennia for glaciers to approach their pre-industrial mass.

Since individuals can only live sustainable when they buy the required amounts of conservation, and since there will be economic and social benefits to living sustainable, the available conservation of each type needs to be made available on a global per capita basis to participating end-user consumers. While starting at zero, only towards the end of the global environmental restoration process, just enough conservation will be available to meet the conservation requirements. Therefore, during most of the environmental restoration period, environmental restoration (and thus TTC) will be in short supply and most participating individuals will run out of their monthly per capita allotment well before the end of the month. Once applied, TTC cannot be "un-applied", re-assigned, or re-sold. In theory, individuals living sustainable may have access to more conservation than is required to be purchased based on their E-resources used and E-damages done. In that case part of their per capita available allotments of TTC will not be used and made available to others. Under the IMACS, E-impact variable values for protection and restoration are calculated separately. For example, wildlife area protection for its biodiversity is valued at different but constant levels of biodiversity, while restoration only values improvements in biodiversity compared to a reference rate of improvement. Under well managed conditions, organizations managing wildlife areas for their biodiversity can sell TTC for protection while separately selling TTC for biodiversity increases. TTC for protection typically represents protection for a given period, while TTC for restoration typically represents an improvement of the underlying E-condition variables irrespective of time (e.g., permanent sequestration of 1 ton carbon).

3.7. Impact Rating Organizations (IRO)

Calculation of amounts and types of environmental damage and the use of natural resources for participating products, services and individual labor will be carried out in a fully automated fashion using the formulas developed for environmental supply chain step calculations under IMACS *(7,8,10).* However, the initial determination of all location-based impacts (LBI) and the estimation of E-impacts of existing "non-rated" product and services, (while also mostly automated) will be carried out by Impact Rating Organizations (IROs). IROs will also measure and monitor environmental conservation. To do so effectively and at minimum costs, IROs will need to be specialized per field. IROs determining environmental conservation and human condition conservation will be specialized to one specific field. Determination of E-damage and E-resource use for most organizations and their allocation to the different products and services will be carried out by general business IROs.

3.8. Standardization of Units

TTCs for the different forms of conservation need to be sold as standardized units. For some types of conservation, the units are easy to define: carbon dioxide emitted and sequestered can both be expressed as tons of carbon dioxide (tCO_2) or alternatively as ton carbon (tC) sequestered or their kilogram equivalents. The same applies to fresh water used, conserved through recycling and produced via reverse osmosis. For other types of conservation such definition is more difficult. For those types, TTC must be expressed under standardized conditions and amounts. This applies to natural fresh water consumption and to biodiversity.

For natural fresh water consumption, the standardized units are more difficult to define, since 1 m^3 of water extracted from lands with an arid climate has a much larger effect on the wildlife species assemblies than the same 1 m^3 of water extracted from a landscape with a wet climate. Using "precipitation area used" for the amounts of natural fresh water consumed is a better measure but requires the conversion of the local volume of fresh water used to the local corresponding precipitation area needed to collect the precipitation.

Virgin wildlife areas in different ecosystems each have a different biodiversity, different (independent) species assemblies, a different connectivity and a different biodiversity resilience. The different biodiversity related variable values and the size of protected wildlife areas will need to be compared and converted to an area of modified size of reference biodiversity. Analogously, increases in biodiversity of wildlife areas can also be scaled to reference increases in biodiversity of a modified area.

The same standardization applies to all other types of EH-conservation.

3.9. Scientific Support

The IMAC system represents a combined scientific and engineering approach to solving the mounting environmental problems that cannot be solved fast enough by governments alone. The IMACS system functions as the catalyst for rapid change, combining effective implementation of scientific and engineering knowledge with gradually improving (but still insufficient) government efforts towards sustainability. Many aspects of the IMAC system require scientific support; measurement of use, protection and restoration of natural resources and the incrementally different methods to be used. For example; to allow a quick start, the various measurements can be crude, using only a few and easy to measure input variables, over time developing in more accurate but more complex measurements. This applies among others to biodiversity measurement, water consumption, soil acidification, soil loss and damage, protection of lands from flooding and to human conditions. The IMACS organization will need to set up scientific committees each supporting one of the eleven IMACS impact groups *(7).* These committees should have global representation by government independent science and technology centers (typically universities) with demonstrated knowledge and experience in each assigned field (impact group). Ahead of such IMACS organization, science centers interested in contributing to a rapid improvement of global environmental conditions are invited to combine their efforts in support of the various aspects for each impact group. Such support could start with the review, editing, improvement and co-publication of the about 1000 pages of draft documents (by this author) distributed over the eleven impacts groups, describing proposed measurement and calculation methods as well as proposed changes to current practices to improve environmental sustainability and human conditions. After this publication, the various rounds of suggested improvements will improve the proposed methods in two directions; allowing a simpler, faster and better initial crude implementation and allowing more-accurate but more complex later improvements. Based on the rapidly deteriorating environmental conditions, such IMACS support by science centers should start ASAP; there is no time to waste.

4. Results and Discussion

Various forms of conservation (wildlife area protection, pollution controls, flooding protection) have been available for half a century or longer, but have not prevented the slide towards an ecological disaster. The implementation of *"Title-To-Conservation"* (TTC) as part of IMACS, can effectively change this. TTC represents a fractional amount of environmental conservation for which the actual conservation is applied in the field but for which the title of doing so it is accredited to the individual end-user consumer in whose name the conservation is purchased. This concept can be the catalyst to fund enormous amounts of any type of environmental conservation over time. While it will be first applied to neutralize damaging environmental (E) impacts, is can also be applied to neutralize human condition (H) impacts through human condition rehabilitation (H-conservation). The use of TTC creates a large customer demand for conservation that is thus far absent. This large customer demand is possible due to the absence of costs to end-user consumers while having very low costs for sellers and later provides cost savings for both participating sellers and end-user consumers. Using C-sequestration as an example, the number of 1-million-tCO_2 per year capacity C-sequestration facilities needed is calculated in tables 1 and 2. Globally the costs of CO_2 sequestration per dollar consumer spending would be very high (14.6%) if all CO2 currently emitted would be sequestered. However, any spending on C-sequestration only applies to the C-sequestration capacity available at any given time. Currently, at zero capacity, the costs would be zero. In table 2 the results of calculations made using table 1 are displayed for different cases of participation. Table 2 has no time scale and we assume that for each row the C-sequestration is available corresponding to the participation conditions. The effects on C-sequestration can be very large, even early after first implementation. Table 2 shows that for participation rates of 1, 2 and 4%, respectively 4, 17 and 66 C-sequestration facilities of each 1-million-ton CO_2 per year capacity are needed. At this rate of participation, the E-voucher costs for retailers without participating suppliers rise for these three cases from 0.0015% to 0.023% (or $ 15 to 230 $ per $ 1,000,000 sales). Retail contributions to GDP will vary globally. With retail comprising ~ 5.7% of US GDP, most of the added value and likely most of the CO_2 emissions would originate from the retail suppliers. A conservative value of 10% is used for the C-emissions contributions by the retail sector.

Global Input Data	Value	Units		Global Calculated Data	Value	Units
Global GDP 2021	9.49E+13	[$/y]		Global annual CO_2 emissions 2021	4.15E+10	[tCO_2/y]
Global annual CO_2 emissions 2021	11.312	[GtC/y]		CO_2 emissions per dollar consumer spending	7.28E-04	[tCO_2/$]
Cost of CO_2 sequestration	200	[$/t$CO_2$]		CO_2 sequestration cost per dollar consumer spending	0.146	[$/$]
% End user participants	1%	%		Spending by participants on participating products	5.70E+09	[$/y]

% Participating products purchased by end user participants	1%	%		Required CO_2-sequestration capacity	4.15E+06	[tCO_2/y]
Consumer spending as % of Global GDP	60%	%		Number of plants of 1-million tCO_2/y capacity needed	4.1	[ ]
				Retailer voucher cost as % of sales without participating suppliers prior to emission improvements	0.00146%	%
Contribution of CO2 emissions by retail sections for average product sold	10%	%		Retailer voucher cost as % of sales with 100% participating suppliers prior to emission improvements	0.00015%	%

Table 1: Number of C-sequestration plants of 1 million-ton CO2 capacity needed and E-voucher costs for retailer at 1% participation for end-user consumers and 1% product participation *(17).* Historic CO_2 emissions are excluded in example.

In that case, for retailers with 100% participating suppliers and employees, the C-sequestration costs drop by a factor ten (0.00015 to 0.0023% or $ 1.5 to 23 $ per $ 1,000,000 sales, see table 2). For these costs, the retailer can boost *"When you participate, we will pay all costs of CO_2 sequestration for all participating products you buy"*. Expressed as marketing costs per unit additional sales, these costs are likely lower than any other form of marketing. For C-sequestration the current costs of 200 $/tCO_2$ sequestered are used. The average costs of C-sequestration over the next 20 years are likely to be closer to 100 $/tCO_2$, while the post 20-year costs are likely to drop to the 25 - 50 $/tCO_2$ range. While the initially low costs for sellers correspond with relatively small amounts of CO2 removed

End-user and Product Participation (% of each)	Number of Plants of 1 million tCO_2/y Capacity Needed	Retailer Voucher Cost as % of Sales without participating suppliers prior to emission improvements	Retailer Voucher Cost as % of Sales with 100% participating suppliers prior to emission improvements
1	4.1	0.00146%	0.00015%
2	16.6	0.00583%	0.00058%
4	66.4	0.02330%	0.00233%
8	265.5	0.09321%	0.00932%
12	597.3	0.20971%	0.02097%
16	1,061.8	0.37282%	0.03728%

Table 2: Number of C-sequestration plants of 1 million-ton CO2 capacity needed and E-voucher costs for retailer at 1 to 16% participation for each end-user consumers and for product participation under conditions otherwise the same as for table 1. For each case (row) the listed C-sequestration capacity is purchased with the E-voucher moneys made available *(17).*

from the atmosphere, it allows the C-sequestration industry to grow at breakneck speed. A detailed model calculating sequestration rates and costs as function of individual and product participation over time will be presented in a later article. As per this writing (2023) the first commercial scale C-sequestration facilities are under construction, using a mix of non-consumer-based financing sources. However, without a solid and growing commercial customer basis, the number of C-sequestration facilities would not grow at all or very slowly. Results for a commercial customer basis corresponding to 1 to 16% individual and product participation are listed in table 2 and shown in figure 1. The results show that the number of commercial sized C-sequestration facilities needed (for which the CO_2 sequestered can be paid using the E-voucher revenues) increases rapidly with participation. The E-voucher costs for the retailer with participating suppliers remains relatively low but are rising. These costs create an incentive to install carbon neutral systems (geothermal heating and cooling system, electric transportation and roof mounted PV solar) which earn themselves back in 5 to 7 years. These costs also create incentives to help employees to become carbon neutral. Once carbon neutral, the costs of E-vouchers for current CO_2 emissions drop to zero, while the savings from using carbon neutral systems remain for both organizations and employees.

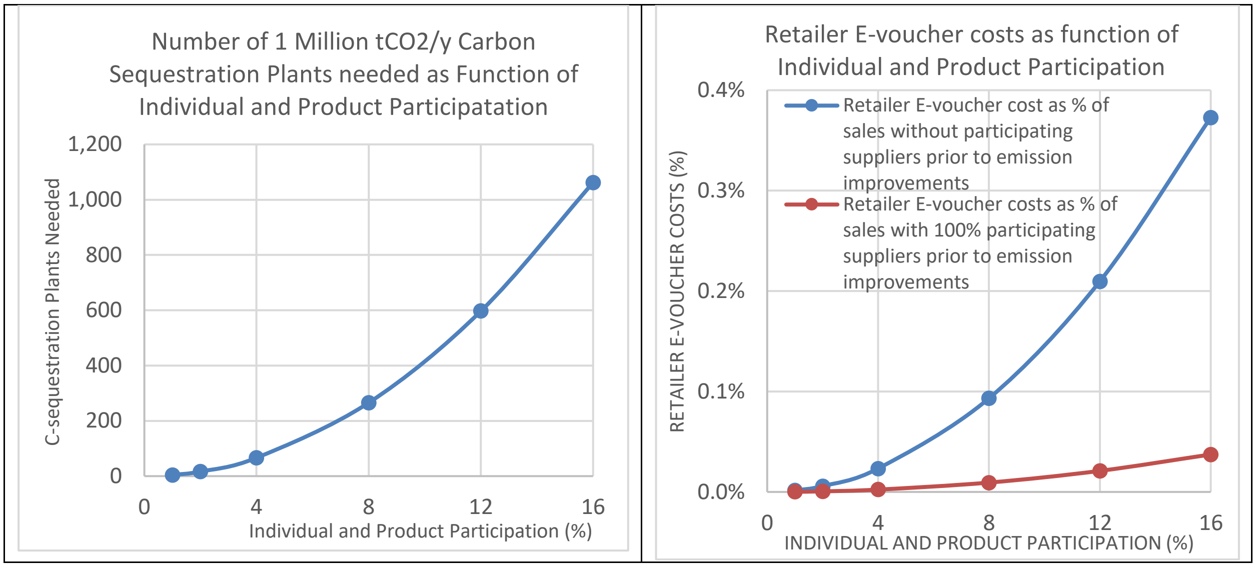

Figure 1: Number of C-sequestration plants of 1 million-ton CO2 capacity needed (left) and E-voucher costs for retailer at 1 to 16% participation for end-user consumers and for product participation (right) under conditions for table 2. E-voucher costs in blue (upper curve) apply to the case where retailers have no participating suppliers. With 100% participating employees and suppliers, these costs drop strongly (lower curve in red). After installation of carbon neutral systems, they drop to zero *(17).*

For other types of conservation, the costs are much lower than for C-sequestration. In addition, additional "terrestrial areas" cannot easily (cheaply or sustainably) be created. For cultivated area use the only option is to use less cultivated area, which by itself does not cost anything, but requires a reduced consumption of meat (especially beef and mutton). With respect to fresh water use, large amounts of water "consumed" can be saved, by no longer growing crops in arid areas but instead in areas where they can grow naturally with only modest irrigation a few days per year. In addition, large amounts of fresh water can be saved by recycling biologically treated wastewater to injection locations around the point of water extraction (instead of injection to rivers or the sea). This will partially restore the natural water flow through the watershed, reduce anthropogenic water stress and reducing forest fires. Any amount of water withdrawn from a location in excess of the sustainable available amount will need to be made up with reverse osmosis water. The costs of such water conservation will weigh strongly on agricultural products grown in arid areas and will be a strong driver for water conservation.

The use of TTC as part of IMACS allows the creation of a network of sustainability driving organizations (mostly businesses) that can rapidly transform the "sustainability landscape" allowing a rapid growth of all types of conservation to not only protect but also restore the environment to the best approximation of pre-industrial conditions. Some types of conservation can provide TTC of multiple types. Organizations protecting wildlife areas for their biodiversity can qualify as Nature Protectorate Organization (NPO). Carbon Sequestration Organizations (CSO) and Precipitation Area Protection Organizations (PAPO) can sell TTC for their types of conservation. Organizations protecting rare soils can qualify as Soil & Sediment Conservation Organizations and can sell TTC. Organizations using dike systems for protection of low-lying lands against coastal flooding, can qualify as Coastal Flooding Protection Organizations. Once IMACS qualified all these conservation organizations can sell TTC.

TTC is sold under conditions of permanent conservation. Restorative conditions will not show a continuous improvement over time, but will reflect periodic and local natural or manmade setbacks. Such setbacks (e.g. reductions in biodiversity of wildlife areas and leakage of carbon dioxide from pipelines and underground storage reservoirs) must be treated as new damage done and need to be restored at no additional costs to the consumer. Note that while applying TTC to sequester carbon represents a positive value, the removal of fossil carbon, standing trees or soil carbon or any other form of carbon from a carbon store, represents a negative C-sequestration value.
The first Impact Rating Organization (IRO) will be started by the IMACS organization and will be continued until sufficient independent commercial IROs are operational. During this initial period, the IMACS organization will set standards and provide training and certification for IRO staff. IRO functions will most likely be provided by one or more staff members of existing management consulting businesses, the type of business best fitting this function. This allows an organic growth of IRO functionality, while the same consulting business can also provide recommendations with respect to other business practices. The original IMACS-IRO will be transformed into the regulatory, certification and compliance wing of the IMACS organization.

Without the availability of TTC, the supply chain step calculations as described *(7,8,10)* merely provide environmental (E) and human (H) condition impact values for products, services and individual labor. While informative, this information by itself would not improve the sustainability of products and services purchased. The use of TTC as part of IMACS allows the automatic and global application of conservation in any fractional amount for any type of conservation, rendering products and services consumed free of impacts. TTC will be made available globally for immediate or future delivery to stimulate a rapid increase of conservation capacity. Sustainable supply chains will start as new thin layers. In a fully participating supply chain layer, the concept where each seller pays for the E-impacts of the products sold, corresponds to *"everybody paying for his/her own damage created"*. Paying for conservation (E-voucher) creates costs. While these costs are initially very low, it creates a strong incentive to prevent rising costs by installing carbon neutral systems and otherwise do less E-damage. After installation and use of carbon neutral systems, the costs for carbon sequestration of current CO_2 emissions drop to zero, while these systems provide a lower cost of energy. The use of TTC will create very large market demand for all types of environmental conservation purchased by paying customers. It also allows restoration of damage done in the past, allowing a path to pre-industrial E-conditions effectively reversing global warming. The E-conservation applied allows the rate of species extinctions to drop the background rate prior to the human existence and creates a path to perpetual sustainable conditions.

5. References

1. Dert, V. (2024). DETERMINING AND/OR EVALUATING A SUSTAINABILITY OF A PRODUCT, A SERVICE, AN ORGANIZATION AND/OR A PERSON (Patent). Zenodo. https://doi.org/10.5281/zenodo.11205155
2. Dert, V. (2024). Impact Measurement and Application of Conservation System (IMACS). Zenodo. https://doi.org/10.5281/zenodo.11206389
3. Dert, V. (2024). Calculation of Individual Sustainable Absorption under IMACS. Zenodo. https://doi.org/10.5281/zenodo.11211511
4. Dert, V. (2024). Calculation Of Excess Impact Deduction for Products and Services under IMACS. Zenodo. https://doi.org/10.5281/zenodo.11212347
5. Harding, G. (1968). The Tragedy of the Commons. Science 1968. The Tragedy of the Commons by Garrett Harding, 1968 (driaj2009.blogspot.com). Capture date 5/17/2024.
6. Recommendation on the use of Environmental Footprint methods, 16 December 2021, Directorate-General for Environment Recommendation on the use of Environmental Footprint methods (europa.eu)
7. Dert, V. Calculation of Environmental and Human Condition Impacts and Application of Conservation. [Provide correct reference to e-Print publication on ArXiv server once available.]
8. Dert, V. Calculation of Individual Sustainable Absorption for IMACS. [Provide correct reference to e-Print publication on ArXiv server once available.]
9. Richter, B. D., Davis, M. M., Apse, C., & Konrad, C. (2012). A presumptive standard for environmental flow protection. *River Research and Applications*, *28*(8), 1312-1321.
10. Dert, V. Calculation of Excess Impact Deduction for Products and Services in IMACS [Provide correct reference to e-Print publication on ArXiv server once available.]
11. Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, F. S., Lambin, E. F., ... & Foley, J. A. (2009). A safe operating space for humanity. *Nature*, *461*(7263), 472-475.
12. De Vos, J. M., Joppa, L. N., Gittleman, J. L., Stephens, P. R., & Pimm, S. L. (2015). Estimating the normal background rate of species extinction. *Conservation biology*, *29*(2), 452-462.
13. Costello, M. J., May, R. M., & Stork, N. E. (2013). Can we name Earth's species before they go extinct? *Science*, *339*(6118), 413-416.
14. Ward, P. J., Jongman, B., Aerts, J. C., Bates, P. D., Botzen, W. J., Diaz Loaiza, A., ... & Winsemius, H. C. (2017). A global framework for future costs and benefits of river-flood protection in urban areas. *Nature climate change*, *7*(9), 642-646.
15. Flynn, K. M., McKee, K. L., & Mendelssohn, I. A. (1995). Recovery of freshwater marsh vegetation after a saltwater intrusion event. *Oecologia*, *103*, 63-72.
16. Thomas, C. D. (2011). Translocation of species, climate change, and the end of trying to recreate past ecological communities. *Trends in Ecology & Evolution*, *26*(5), 216-221.
17. Dert, V. (2024). Excel Model for DACCS Capacity and Cost for Global Warming Reversal under IMACS. Zenodo. https://doi.org/10.5281/zenodo.11200071