

Conceptual Framework

Deliverable D1.2

Anne Snick (VITO)

VITO NV _ Unit Sustainable Materials Management / Boeretang 200, 2400 MOL, Belgium.

<http://www.fotrris-h2020.eu>



This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 665906

Document Information

Grant Agreement #:	665906
Project Title:	Fostering a Transition towards Responsible Research and Innovation Systems
Project Acronym:	FoTRRIS
Project Start Date:	01 October 2015
Related work package:	WP 1 - Conceptualisation of Co-RRI
Related task(s):	Task : 1.3
Lead Organisation:	VITO
Submission date:	29/10/2016
Dissemination Level:	Public.

History

Date	Submitted by	Reviewed by	Version (Notes)
04/08/2016	VITO	VITO	V1
05/10/2016	VITO	Consortium	V2
25/10/2016	VITO	IFZ	V3

Table of content

About the FoTRRIS project	4
1 Introduction	5
2 Responsibility means contributing to systemic solutions to global challenges.....	6
3 A common denominator for the crises: Anthropocene	6
4 Planetary boundaries determine the parameters for CO-RRI.....	7
5 Evolutionary framework for CO-RRI: growth, collapse and emergence.....	8
6 CO-RRI is required in response to a historical lock-in.....	9
7 CO-RRI allows emergent more adapted valorisation systems to upscale	11
8 CO-RRI decentralises and democratises the development of knowledge.....	13
9 CO-RRI co-designs ‘great solutions’ integrating different types of innovation	15
10 CO-RRI development – prototype and next steps.....	17

About the FoTRRIS project

FoTRRIS develops and introduces new governance practices to foster Responsible Research and Innovation (RRI) policies and methods in Research and Innovation (R&I) systems.

FoTRRIS stresses that RRI is a collaborative activity from the very beginning. Therefore FoTRRIS adds the prefix 'co' to the acronym RRI. Important present-day challenges are of a global nature but manifest themselves in ways that are influenced by local conditions. Thus, FoTRRIS focusses on glocal challenges, i.e. local or regional manifestations of global challenges and on local opportunities for solving them.

FoTRRIS performs a transition experiment, i.e. an experiment to support the transformation of present-day research and innovation strategies into co-RRI-strategies. It designs, tests and validates the organisation, operation and funding of co-RRI competence cells. A competence cell is conceived as a small organisational unit, which functions as a local one-stop innovation platform that encourages various knowledge actors from science, policy, industry and civil society to co-design, -perform, and –monitor co-RRI-projects that are attuned to local manifestations of global sustainability challenges.

Since research and innovation systems and practices in EU member states and within different research performing organisations vary, FoTRRIS experiments the implementation of new governance practices in five member states. These five experiments are evaluated, validated and constitute the basis for FoTRRIS policy recommendations towards EU and member states policy makers so as to enforce co-RRI into the national and EU R&I systems. Training is dispensed to various stakeholders, so as to form them to establish other co-RRI competence cells.

For more information see <http://www.fotrris-h2020.eu>



Coordinator contact:

Jan Meneve / Unit Sustainable Materials Management / VIT NV / Boeretang 200, 2400 MOL, Belgium.
t: +32/14 33 58 46 | e: jan.meneve@vito.be | w: www.vito.be/english

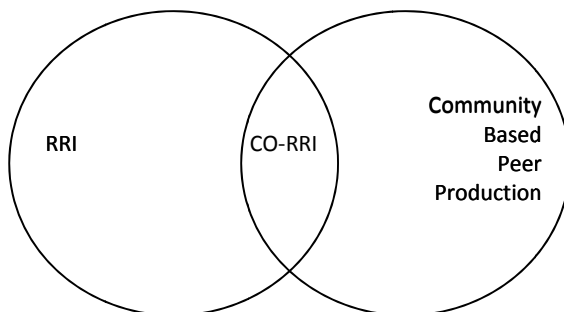
Framework for Community-Oriented* Responsible R&I (CO-RRI)

*'Community-Oriented' may be substituted by 'Cocreative' or 'Collaborative' according to local sensibilities or preconceptions.

1 Introduction

This conceptual framework is a working document (to be tested) within the FoTRRIS-project. The concept of 'Community Oriented Responsible R&I' (or 'CO-RRI') is proposed as a synthesis of the crucial characteristics of **Responsible R&I developed in collaboration with citizens, CSO's, companies and public services for common wellbeing.**

This orientation towards (local) communities is what distinguishes FoTRRIS from many other RRI-projects. RRI is introduced into the Horizon 2020 policy with the aim of orienting R&I towards finding solutions for the big challenges of our societies. For R&I to be responsible it should also integrate six thematic lines: citizen engagement, gender, governance, education, open access and ethics. FoTRRIS considers public engagement not as a feature that is added in later stages of the RRI-process, but as a building block of RRI itself. RRI is not possible without deeply democratising R&I. Solutions for the big challenges can only succeed if they imply society and recognise the innovative competences of citizens in communities as a basic building block of RRI. Yet, to integrate this community based innovation – in which citizens are recognized as peers – into the current R&I landscape requires specific infrastructure, methodologies and policies. This FoTRRIS aims to develop.



This text addresses the following questions:

- A. What is the **justification** for CO-RRI? What core features allow CO-RRI to offer a 'just response' (be 'respons-able') to the anomalies of the current paradigm? This is outlined in steps 1 - 3.
- B. What explains the historical **necessity** of CO-RRI? What pressures in the current landscape force us to create more adapted¹ R&I infrastructure and policies? Steps 4 – 6 clarify this.
- C. What are the **contours** of RRI today? Why and how does CO-RRI merge specialist and community-based knowledge into an R&I system more adapted to complexity? Steps 7 - 9 address this question.

This document proposes a 'draft' frame of reference for the concept of CO-RRI. Its function is to facilitate communication of the members of the consortium with their partners and stakeholders. Five case studies will test and validate this framework so as to foster the uptake of CO-RRI in Europe. The text is interspersed with examples (in green blocks of text) that in themselves are not part of the conceptual framework but serve only to clarify its building blocks.

2 Responsibility means contributing to systemic solutions to global challenges

R&I has always been an important economic driver. Today the world is facing big ecological and social crises and in many parts of the world the economy is struggling. It is commonly agreed that Responsible Research & Innovation (RRI) should aim at solutions for these challenges. However, what is to be understood by this 'responsibility' and who is responsible for what, is still a matter of debate. What we do know is that current threats are complex systemic problems at a global scale. Therefore CO-RRI must adopt a *systemic* approach to understand the root causes of these phenomena. This will allow R&I to contribute to solid solutions and to reveal what policies, social innovations, economic models and technologies are needed to restore planetary and social wellbeing. CO-RRI should be a catalyst of change allowing the global society to find systemic answers for the crises. This avoids tackling only certain drivers of the crises while being blind for others, or aggravating the crisis while making us believe we solved it.

Industrial fishing uses technology that increases its productivity. This causes the depletion of marine populations. As certain kinds of fish become scarce (species extinction as a big challenge), their price may rise, making it even more profitable to catch them. From an economic perspective, investments in more aggressive fishing technologies seem worthwhile. Next, in order to have a return on this investment in new fishing technology, even more of the fish has to be caught. Eventually this leads to the collapse of the fish population (and of the fishing industry). Thus technology designed in response to fish depletion actually often aggravates the problem, because the economic driver of the depletion (profit oriented investments) is not addressed. CSO's on the other hand develop innovations such as 'Marine Stewardship Council' which not only safeguard the survival of marine life, but also make fishing companies more sustainable and allow future generations to still have fish. For this type of innovation to have sufficient and timely impact (and so, to avoid collapse), governance measures will be required.

RRI is responsible insofar as it justifies what aspects of complex socio-economic and ecological dynamics it takes into account for tackling big challenges. Given the global scale of today's crises, CO-RRI takes the planet earth as a relevant context. It contributes to R&I that respects or restores planetary ecosystems sustaining life, and pursues equal access to healthy ecosystem services for all (including future generations and other species). **Environmental ethics** are at the core of RRI, i.e. a moral commitment to safeguard access to ecosystem services such as clean air, water, soil, food and material resources for all beings, including future generations.

3 A common denominator for the crises: Anthropocene

Scientists call the current era the Anthropocene since human economic activity influences the dynamics of the planetary system and leads to problems like climate change, oceanic pollution, soil erosion and mass extinction threatening human survival. This comes as a shock, since for centuries politicians and economists predicted that growing economic productivity (combined with social legislation) would bring wellbeing for all. Yet with spreading industrial activity we see the depletion of natural ecosystems and unequal access to increasingly scarce resourcesⁱⁱ. This entails loss of economic perspective in many regions of the world, mass migration, geopolitical tensions and security threats, problems our political and social institutions are not prepared forⁱⁱⁱ. Moreover, since the 2008 crash the economic engine itself is faltering in many countries. At first sight this seems to make it hard to address the crises. Yet, if current economics are causing the threats, it is unjustified to believe that 'more of the same' is the cure^{iv}. These unpredicted outcomes (anomalies) reveal that the current paradigm is untenable^v, and lead to the emergence of alternative economic practices and paradigms.

R&I has long been driving economic growth. It provided innovations allowing companies to bolster their competitiveness by increasing resource throughput at a lower cost. It brought innovation *within* the very

economic model that is today identified as a driver of planetary and humanitarian crises. In a sense R&I is co-responsible for these problems, as it sustained a destructive economic model. The emergence of RRI means that the science community assumes this responsibility. For CO-RRI to lead to solutions for the threats, it must necessarily include innovation of the economic model itself.

A key factor in this paradigm shift concerns the notion of value. The current economic model expresses value mainly in financial terms, and negotiates this value on a market designed as a space where participants compete with each other to increase their private profits. Human labour and planetary resources are thus treated as means to increase financial value. RRI with a view to restoring human and planetary wellbeing therefore will depend on the introduction of other values, ones that respect planetary boundaries and contribute to social justice and solidarity.

In the current economic paradigm companies make profits by decreasing costs and increasing sales. Technological production (machines replacing human labour) lowers costs; for investments in those investments to yield a return, sales have to be kept high. From an economic viewpoint marketing techniques like planned obsolescence or launching new versions of a product while taking repair parts of older models out of production are smart innovations. This model leads to depletion of resources, accumulation of waste and concentration of wealth in the hands of economic actors who successfully apply these strategies. From a social and ecological viewpoint it would be more rational for consumers to share (access to) tools, to reuse and repair them. As this lowers sales (degrowth), new economic models should be adopted and different value systems introduced, allowing producers to do business without increasing material throughput, and allowing all citizens access to the resources they need for a quality life, without destroying the planetary ecosystem.

CO-RRI aims at increasing economic prosperity and social justice within planetary boundaries. How this can be conceptualised and organised is itself a matter of learning and innovation. CO-RRI must include research on and innovation of the economic model and the introduction of alternative value systems so as to contribute to human and planetary wellbeing.

4 Planetary boundaries determine the parameters for CO-RRI

RRI should contribute to ‘economic growth’ that guarantees a dignified and healthy life for all beings within the boundaries of the planet. It therefore has to acknowledge the basic laws of the planetary system and find new economic models that bring prosperity in a planet which is a semi-closed thermodynamic system. This means:

- a. There is **no exchange of matter** with the surrounding space. Growth of productivity in one place inevitably causes depletion and/or pollution in other places. Most economic theories do not include these facts in their mental models and treat them as ‘externalities’ or ‘side effects’. Since this type of economic activity is rolled out globally, externalising is no longer possible. The backlash comes in the form of climate change, depletion, pollution and mass migration. This feedback forces RRI to recognise the planetary context as the real basis for justified economic models.
- b. There is **exchange of energy** with the surrounding space. The best known source of external energy is the sun. Solar heat is distributed unevenly between the earth’s equator and poles, fuelling weather systems that in the course of evolution have created ecological niches (climate zones, ecosystems, soils...) and spurred other energy sources (wind, water...). Plants turn solar energy into carbon and feed other forms of life, produce useful materials and yield energy. The yearly influx of solar energy determines the amount of *renewable* energy and (plant) matter that is available for economic use.
- c. There is always an **increase of entropy** (or disorder). Entropy refers to the degree in which energy or matter are dissipated and become unavailable for use. In the evolution of Earth it is solar energy

that creates order (life, available energy) and keeps the planet from reaching maximum entropy (death). In the course of evolution stocks of (mineral or fossil) materials have formed that are available for use. But once extracted, used and dissipated in the environment it is hard to retrieve them in a useful form and they may even become harmful. Efforts to 'restore order' always require higher inputs of resources and energy, and so at a large scale speed up overall (external) entropy. Products can be recycled but their quality always degrades (entropy); up-cycling (restoring internal order) requires extra resources and so increases overall (external) entropy.

Most plastics are made from oil (an available source of energy), but once the plastic is used, thrown away, dissipated in the oceans, broken down to plankton-size particles and consumed by fish, is no longer available for economic purposes and impairs marine and human health.

Europe has few mines for metals, so the metals present in obsolete products (such as mobile phones or car catalysts) are its main stocks of useful atoms, but they require complex recycling technology. Nanotechnology to a large degree makes it impossible to retrieve useful atoms and thus leads to increased entropy.

For human survival it is crucial to change socioeconomic systems so as to restore internal order (increased prosperity for people and other beings) while keeping overall entropy low. CO-RRI contributes to this by gathering expertise on socioeconomic practices that are more adapted to planetary laws and by promoting societal models that guarantee access to a quality life for all people and restore planetary ecosystems.

5 Evolutionary framework for CO-RRI: growth, collapse and emergence

CO-RRI is to provide answers to crises that threaten life as we know it. Throughout (pre)history, life on earth has gone through several extinctions after which new forms of life emerged. The best known is the ecosystem collapse in which the dinosaurs died out. These were 'successful' animals, capable of a huge throughput of matter and energy. This however made them extremely dependent on (food from) specific ecosystems, and unable to adapt timely to a sudden change in the environment. Small, more adaptable mammals survived and eventually evolved into new (emergent) forms of life. By studying the solutions that nature uses to sustain life (biomimicry^{vi}), we can learn how to adapt to changes in the context.

Research reveals that sustainable systems can be compared to dynamic networks keeping a balance between two opposite features. Their ability to efficiently maximize production or throughput depends on streamlining processes that are adapted to (and successful in) a given context (internal order, increasing external entropy). Their resilience on the other hand depends on their capacity to allow for divergent processes, maintaining a degree of freedom that diminishes efficiency but increases adaptability. Sustainable systems in all kinds of contexts show a surprising consistency in their degree of order at around forty percent, whereas divergent pathways account for sixty percent of their flows. The dinosaurs' high efficiency (adaption to a specific context) caused their collapse after a context change, while small mammals' resilience and adaptability allowed for the emergence of new life forms. As these life forms get successful (efficient), they in turn have an impact on their context, leading to changes that again require adaptability. Governance for sustainability means maintaining the right balance between freedom (60% adaptability) and order (40% efficiency)^{vii}.

The current economic infrastructure is extremely efficient at maximising energy throughput, turning other forms of life and planetary resources into means for economic growth far beyond the yearly renewable

influx. This sociotechnical regime is strongly institutionalised on a global scale and very slow to adapt. Yet, as a response to dramatic and threatening context changes, small niches of alternative socioeconomic practices are emerging worldwide, more in tune with the laws of the planet and oriented towards local or global wellbeing.

There are many examples of extremely successful companies that were slow to adapt to new technologies and consumer demands, and went out of business. Today increasing scarcity of raw materials and increasing pollution threatens industry's capacity for large scale production. The industrial model based on a linear-extractive model of first mining resources, then using them for production and consumption of goods, and finally depositing (or incinerating) them as waste. The current crises lead to the emergence of innovative initiatives that make much better use of resources while giving citizens access not so much to ownership of products but to the function or service they offer. Well-known examples are car and bike sharing, tool libraries or community maker spaces. Innovative companies adjust their business model from 'selling products' to 'selling functionality,' and change their mission from increasing profit to producing benefits for society. In these model planned obsolescence is no longer in the interest of the company nor fits its vision. Emergent practices explore more adapted ways of allocating resources to the needs of all. Yet, business legislation and financial systems create lock-ins. If a company sells light instead of lamps, as long as it is forced to make a profit, it will (have to) stimulate consumers to consume as much light as possible. CO-RRI therefore also explores the politics that are required for a more sustainable socio-economic organisation.

The sustainability of society depends on its capacity to upscale resilient initiatives; research in process ecology suggests that sixty percent of socioeconomic transactions should be enabled through innovating pathways while efficiency accounts for forty percent. CO-RRI aims at up-scaling more adapted socio-economic approaches and at designing R&I infrastructure that assures high resilience in the long term.

6 CO-RRI is required in response to a historical lock-in

RRI is needed to design socioeconomic models that guarantee the prosperity of all life while respecting the yearly influx of resources and causing minimum entropy. Economics is a human activity shaped by political and scientific decisions that are in turn influenced by historical events and evolutions. Yet sociocultural processes also crystallise into less adaptable institutions and habits. These institutions tend to be seen as realities taken as a 'given' rather than as a process based on choice and values. CO-RRI focuses on economics as a societal function and fosters the uptake of emergent more adapted infrastructure, practices and value systems.

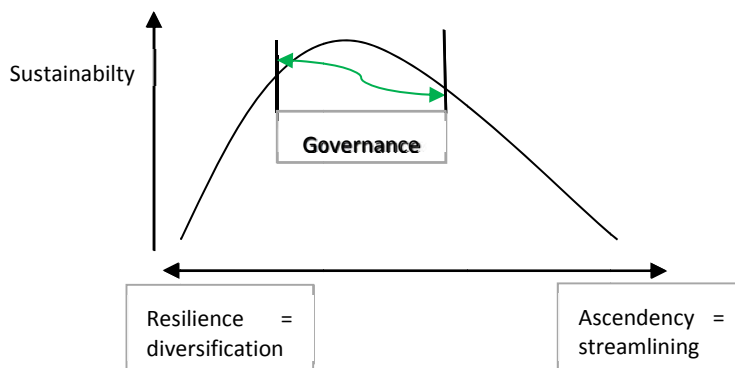
The economic function can be described as 'the efficient allocation of scarce resources to the wellbeing of all.' As the earth is a dynamic system shaped by fluctuating energetic, thermodynamic and evolutionary factors, this requires *ongoing* adaptation by research and innovation. It forces humankind to *constantly* find more adapted ways to allocate (renewable) resources available at a given time and place to all needs. The current economic system is dysfunctional since it opposes life sustaining ecosystems and contributes to social inequality while pursuing its own growth as a goal in itself. CO-RRI must clarify what drivers explain this escalation and what leverages for up-scaling niche innovations can bring timely change.

A **historically unique** event has steered economic processes on a path away from 'normal' planetary laws. Stocks of billions of years of solar energy (in fossil form) were found. This accelerated economic activity to a degree surpassing many times the annual influx of energy and resources. It spurred the creation of infrastructure based on (diminishing) stocks of non-renewable energy and natural resources^{viii}; this led to centralised, industrial production units whose aim is to make a profit (by selling a maximum amount of products at the lowest cost). The consequent greenhouse gasses released in the process exceed the

absorbing capacity of the planet; this capacity comes from plants (photosynthesis) which depend on complex ecosystems that are themselves also degraded by human industrial activity.

This historically 'unique' economic infrastructure appeared efficient in a context of fossil energy, but brought dramatic context changes that ask for an urgent adaptation. However, it is so strongly institutionalised that the term 'economy' today is mainly used to refer to this system; this makes it hard even to think of economics again as a function. The economy is seen as a sector whose growth is deemed more important than the thriving of people and planet, a means-ends reversal. Achieving the aim of prosperity again will require the reform of this infrastructure and the 'regrowth' of our capacity to fulfil the economic function.

Research on the sustainability of complex flow systems reveals that this depends on three structural elements (graph 2).



Graph 2. Curve of sustainability of complex flow systems^{ix}

Firstly it requires resilience, i.e. the capacity to choose alternative paths to pursue its goal in case of a crisis. If a farm grows diverse crops with varying harvest dates, it will survive if a storm ruins one crop. But if an ecosystem just consists of small niches competing for energy, resources may get dissipated and make the system stagnate. So a second element is ascendency, i.e. the capacity to process larger amounts of energy and reducing overhead. Agro-ecology uses combinations of crops that allow for maximum productivity on a given surface, selecting plants (e.g. basil, tomato and grape) that among them optimally share light, water and nutrients and yield plural crops on one plot of land. Reducing diversity (selection) raises ascendency, moving the farm (system) towards the curve's apex. But too much streamlining leads to a tipping point where chances of success decrease again. Monocultures are hyper-ascendant (far removed from resilience). They extract resources while excluding other flows that can replenish them, and in case of a collapse no alternative paths are available. Resilience and ascendency depend on diametrically opposed parameters (much - little diversification) and have to be balanced. So the third factor is governance, the capacity of a system to adjust resilience or ascendency in response to changes in the context. These correcting feedback loops (bent arrow in the graph) have to be active before the system is too far on the downward slope, keeping it within a 'window of viability' (between the two short lines around the curve's apex). When (socio-technical) regimes get too ascendent and collapse, the system often veers up by the emergence of resilient (very 'different') niches. This implies that CO-RRI (up-scaling niche innovations in the light of great challenges) should no longer be valorised using the instruments (such as Intellectual Property Rights) of the regime institutions that contributed to the crises in the first place. In evaluating RRI-projects the number of patents should no longer be used as a (positive) indicator for success.

Until 1955 polio was considered one of the most threatening public health problems in the world. In the post-war United States, annual epidemics killed thousands of people, many of them children. When Jonas Salk in 1955 found a vaccine, he did not patent it, which helped to bring the disease under control rapidly. A solution to a big challenge that is used for private profit rather than public benefit, loses its impact. Within the EU Horizon2020 program an important part of the budget goes to responsible research and innovation in response to big challenges (Responsible R&I). Given the urgency and potential devastating impact of these challenges on human and planetary wellbeing, this R&I can only contribute to solutions if it

is shared widely and is made freely accessible. This inevitably means R&I institution should not patent the results; in the model of RRI that the EU proposes, open knowledge is one of the six dimensions. However, since in the current economic system patents are an important source of income for R&I institutions, the shift to RRI will also require these institutions to valorise their work in an innovative way that allows them to stay in business.^x

CO-RRI restores the economic function – as the aim of political governance - which the current (fossil based) economic infrastructure inadequately serves, and explores innovative niches of (resilient) means and infrastructure that contribute to this. It also explores the leverages which may help current regime institutions (both in R&I and business) to adapt to these new models and paradigms. CO-RRI aims at ‘regrowth’, i.e. increasing our capacity to sustainably allocate resources to the needs of all while keeping entropy low.

7 CO-RRI allows emergent more adapted valorisation systems to upscale

Debates on RRI always entail the question whether there is enough money to solve ecological, geopolitical or social problems. Money is an agreement within a community to use something as a means of exchange in a systematic way. Saying ‘there is no money for sustainable development’ in fact means ‘the current agreements do not allow us to allocate available resources to human and planetary wellbeing’. Yet, as a response to the crisis societal resilience leads to the emergence today of numerous alternative financial models and practices, designed with a view to facilitating a more sustainable circulation of resources and to valorising all work that contributes to this aim. These initiatives appear as leverages in the context of other emergent practices and policies, such as networks of sustainable cities or communities or the circular economy^{xi}. So for RRI to restore the societal rewarding function and foster the development of resilient economic infrastructure, it also has to innovate the ‘agreements’ that are used to allocate resources and contribute to the innovation of the financial system. Therefore it is crucial to understand the lock-in of current money.

Industrial scale production was made possible by the centralisation of capital and power. National governments gave private companies (banks) the sole power to create money and to impose rules for financial transactions. Today money is created virtually when banks write out a loan (digits on an account) to be paid back by the debtor with an interest. As digits are unlimited in number, debt can grow endlessly. Economic actors however cannot repay debts by adding digits to the bank’s account, but have to ‘make money’ in the real economy on a non-growing planet. Money is thus systemically imbalanced since (virtual) outflow is larger than (real) available inflow. That makes it ‘scarce by design’ and urges economic actors to exploit human and natural resources, extract profits via speculation on resources and worry more about price than about social or ecological value.

The monopoly of the current monetary system creates a lock-in since it is seen as a given rather than as an agreement that has to be (re)designed for the common good. It makes pursuing ones self-interest *seem* more rational than fostering common wellbeing, and it impairs our adaptability. If companies use waste as raw material (circular economy) this should decrease entropy; yet as companies are required (by scarce money) to make short term profits, they remain in a linear economy mode of production that needs growing flows of waste as raw material and brings forth even larger amounts of waste. Taxes raised to restore the common good are payable only in money that disrupts common goods. Governments expect businesses to respect ecological and social rules yet force them to compete for extractive money, a double bind or a catch 22 situation, explaining behaviour like tax evasion or information distortion.

In the industrial era ‘work’ is narrowly defined as being employed for (private profit of) a company rather than as contributing to the wellbeing of the community. The term ‘income’ since then denotes a monthly payment on one’s account instead of ‘access to collective (human or physical) resources needed for a quality life’. This narrow view has been institutionalised in legislation and social security systems, and still today has a negative impact on the status, wellbeing and empowerment of people (mainly women) who

take care of future generations or community wellbeing. The profit-drive entails a scarcity of and competition for jobs. Available human resources are left unused (unemployed) while work needed for social or planetary wellbeing is left undone. Concepts like ‘work’ and ‘income’ therefore have to be redefined to restore the economic function.

Today more cooperative niche financial systems (e.g. the gift economy, local currencies, social crowdfunding, ethical investments or interest-free loans) are emerging worldwide, mobilising resources to meet community needs which the private profit market does not meet or for which governments do not have the financial resources. Local communities set up exchange systems of mutual aid that serve goals like elderly care and social cohesion or a cleaner and greener environment^{xii}. These initiatives raise access to resources (i.e. regrowth of ‘income’) without fuelling exploitation. In response to poverty they valorise all human talents that contribute to community or planetary wellbeing without exclusion or exploitation, respecting the needs of next generations. Companies design combinations of local and bank currencies to make their goods and services accessible to people in poverty. Yet since societal (including cultural and linguistic) habits are hard to change, the economic potential of these initiatives is not recognized, resources remain unused and needs unmet. Current legislation moreover does not allow them to upscale and to realise their full potential as elements of a more sustainable socioeconomic infrastructure. CO-RRI has to turn these initiatives into catalysts of change by making them visible, raising awareness of their value and fostering political support.

In one EU-country citizens were given money (subsidies) when they installed solar panels on their house as an incentive to foster the energy transition. Yet, these subsidies were given in Euros, so citizens who could afford the investment then received money with which they could e.g. buy plane tickets. So while the cost for the government was high, the impact on energy transition was uncontrollable and may have been negative.

In the same country a public waste company launched a local currency to valorise actions citizens take to prevent or recycle waste, e.g. putting a ‘no ads’ sticker on their mailbox. With this local currency citizens can buy only goods or services which further contribute to sustainable behaviours, e.g. bus tickets or a composting bin. Interestingly, part of the income of this waste company came from selling old paper. So their societal mission (prevent or reduce waste) was in conflict with their economic mission (to be a profitable company). The combination of local money and euro’s radically changes the business model of this company, allowing it to find a solution for the big challenge (reducing waste).

CO-RRI fosters the development of exchange systems that valorise and exchange resources and lead to regrowth of the economic function. It supports the valorisation of all roles needed for human wellbeing and fosters gender equality. It builds knowledge on innovative monetary systems that are designed in response to the crises. It investigates what governance they need and how communities can integrate them in their economic fabric.

Modelling impact of various scenarios on economic function and on social/ecological wellbeing (example)

Economy Scenarios	Used % of Yearly Available Resources = R	Allocation by means of	For % of World Population’s Wellbeing = P	P/R-Ratio = Regrowth index	Impact on context
Current situation	150 Earth Overshoot ^{xiii}	Monopoly of scarcely designed (extractive) money	20 - Worldwide competition & poverty	20/150 = 0,13	Social, ecological and geopolitical threats
Further growth (Business	160	Competition &	15 - Capital	15/125 =	Lock-in

As Usual)	Increasing entropy	speculation for financial profit	Accumulation	0,09	further aggravation of crises
Inclusive & green growth	120 Global (external) entropy remains	Competition with (patented) clean products and services	25 - Social corrections	25/120 = 0,21	Slowing down crises, but without systemic solutions (lock-in)
Regrowth supported by CO-RRI	100 Entropic degrowth	Innovative financial rules & community currencies serving common goals	100 Solidarity & cooperation	100/100= 1 Baseline	Access to (commons based) resources to fulfil all functions (= impact)
Sustainable Regrowth	80 Further decoupling – impact decoupling ^{xiv}	Community Oriented RRI up-scaling & fostering uptake of new economic paradigms	105 = Including next generations with population growth	105/80= 1,31 Regrowth	Restoring ecosystems, social justice & prosperity
“CO-RRI” requires integration of →	Social & technological innovation	Financial-economic innovation	Participatory & collaborative research Community Oriented	Systems thinking (mental) maps	Governance for sustainability (60%-40% rule)

8 CO-RRI decentralises and democratises the development of knowledge

Scientific insights on emergence of order in complex systems reveal that most domains of human behaviour cannot be regulated by reductive systems. Reductionism breaks down complex systems into their constituents parts and try to predict the outcome of the whole based on the knowledge of the basic elements, like a clockwork. However, this does not allow to account for non-linear (or chaotic) processes in which chance plays a role and which turn out to determine almost all of human behaviour. So for RRI to facilitate the resilience of complex human socioeconomic systems, it should build on the knowledge of how order (or ‘life’) emerges in complex dynamic systems. From observing how live ecosystems reach states of relative stability and order, RRI can then create the circumstances in which this learning can be applied to socioeconomic adaptation^{xv}. In terms of R&I this means that specialist (or reductionist) knowledge is not able to produce solutions for problems (or create order and control) in a complex dynamic system like the planetary ecosystem. Adaptability and emergence of new order appears to come from bottom-up input, converging over time into new, self-organised and self-adaptive structures that appear to be more accurate than specialist – centralised – knowledge is able to produce^{xvi}. This insight is a basic building block for Community Oriented (or Collaborative or Cocreative) RRI. For innovation processes to result in self-adaptive and self-correcting solutions adapted to the complex dynamic (non-linear) ecosystem of (life on) the planet, it needs infrastructure where this collective, bottom-up adaptive capacity is facilitated and fostered. Local communities have embedded knowledge of local needs and resources and can create solutions for local manifestations of global crisis based on short feedback loops, allowing for rapid adaptation. For certain aspects of these solutions, more distant connections are also needed, but in diminishing degrees (following a power law). This means that decentralised infrastructure to foster local

solutions to global threats (or ‘glocal RRI’), supported by a diminishing number of institutions at the meta-level (all the way up to the global scale) is what is needed for rapid adaptability.

Fossil-based infrastructure typically centralises production of goods or services *for* consumers. In line with this top-down approach classical R&I sees citizens as objects of knowledge or users of innovations. To improve sales R&I may involve users at some point in the design process, but the aim remains private profit rather than the prosperity of society or the democratization of science. R&I is embedded in specialised institutions requiring a centralisation of resources and money. They are economic actors that make money by privatising knowledge through intellectual property. The concern to generate incomes steers them towards lucrative (high entropic and short term) sectors, and they tend to see citizens as consumers of their innovation rather than as co-creators of knowledge and innovation in view of a societal transition.

Innovative initiatives emerging in response to big crises are more decentralised. In line with the laws of the planet they rely on renewable resources that are available locally in varying quality or quantity. New allocation systems foster the use of these resources for the needs of the community. The ‘market’ of private profit driven initiatives does not guarantee collective wellbeing, while public services lack the flexibility to steer away from the industrial model. Emergent alternatives invest in a new kind of public space where resources are allocated to the common good while involving citizens as ‘prosumers’, both producing and consuming the services they create. This space for economic regrowth is situated at the level of local communities in between the private market and the state^{xvii} and its capacity for increasing resilience is today the object of international scientific research^{xviii}.

Local communities and cities are able to adapt more quickly to local contexts than the globalized private market or the central government. They are large enough to be able to pool (human and physical) resources and to operate their own allocation systems for the common good. They are small enough to allow for short feedback loops from direct contact with citizens in their daily environment. Cities have more flexibility for different policy departments to join forces in innovative initiatives than the whole nation, where the high level of power understandably requires increased levels of regulation and stricter procedures. Regions can create cohesion around a common identity motivating people to invest in local environmental quality and economic resilience. Citizens can be more easily encouraged to engage in work for the community as they readily feel the positive impact of their efforts and have access to the results. Situated between the private profit-oriented market and the centralised state. That makes them into ‘real life labs’ for CO-RRI.

Emergent niche initiatives often lack adapted legal and institutional leverages to upscale. Current legislation is based on the assumption that economic relations essentially pursue private profit and thus are exploiting; this is institutionalised in business legislation. Only environmental and social legislation curbs excesses of exploitation and makes the competitive model (seem) more ‘just’. Commons however are built on relations of cooperation. People pool their resources and govern them collectively with a view to increasing common wellbeing, blurring the lines between owner and renter, employer and employee or producer and consumer^{xix}. Existing legislation does not offer adequate models to formalise those new relations. For the economy to reach a level of sixty percent ‘resilient’ transactions, leverages at higher (legal and political) levels are urgently needed. This involves specialist knowledge developed by CO-RRI. To raise societal adaptability this knowledge cannot be privatised but must itself be a common good (open access).

If you want to put up a picture, what you need is a hole made in the wall (access to a function), not a drill (product ownership). Commons increase access to functions by pooling resources. Local Exchange & Trade Systems or Mutual Aid Networks encourage people to ask a neighbour to drill the hole in return for some other help to the community. Tool libraries give access to machines owned by (someone in) the community and define rules and regulations for use.

CO-RRI-infrastructure to strengthen the potential of regrowth initiatives is organised in the public space that appears next to the private market and state and creates dynamics that also force companies to adapt their business models. The role of the state is to create new legislative frameworks for these resilient innovations. Commons initiatives are ‘real life labs’ where citizens, CSO’s and companies try out more

adapted practices and models. Local CO-RRH-hubs help them to upscale by exploring higher (political, monetary or technical) leverages, systematise the expertise they co-produce and make it freely accessible.

9 CO-RRH co-designs ‘great solutions’ integrating different types of innovation

Traditional R&I institutions are built on specialist, non-systemic mental models. This explains why economic science for centuries could deny physical laws, why technologies that solved one problem could create huge problems in other domains and why money is considered as a given rather than as a social construct. Economics rely on ‘robust’ mathematics. However, calculating economic functionality in a complex dynamic flow context (Earth) implies copious variables defying linear proof or calculation. Therefore economists use a limited number of quantifiable parameters such as money, productivity or jobs, and neglect others. Economic laws are valid *ceteris paribus*, i.e. *supposing* other factors remain unchanged. If economic success is measured with bank money as only unit of account, ‘more’ (profit, productivity) will seem ‘better,’ even though in our planet more (growth) leads to increased entropy and *loss* of economic functionality. The use of GDP (a financial parameter) as an indicator of economic growth does not reflect the well-being of the people or the planet, even though those should be the real aims of economical politics. Innovating the industrial (technical) infrastructure so as to allow for more circular production processes is a necessary condition for more adapted economics, yet as long as the overall goal of economics is to increase financial growth, this will not be a sufficient condition. Social and monetary innovation, supported by legal frameworks and political measures, will be required. CO-RRH integrates all these strands of innovation.

Initiatives emerging today use a more integrative, holistic approach. Social innovation – redesigning economic relations including care and community work – is combined with monetary and technological innovation; innovative governance models and ownership regimes make functions accessible to more people while using less natural resources.

*In order to make the transport sector more sustainable, a lot of R&I and public regulation concerns the **technological** aspects of cars (making them ‘cleaner’). Yet, as long as the **economic** model (aiming at financial growth) remains unchanged, car companies are in a double bind between ‘selling more cars’ (i.e. keeping the price low) and ‘making cleaner cars’ (i.e. making cars more expensive). From a systemic viewpoint it is this double bind that drives companies to falsify data (appearing clean while keeping costs low). Also, even if cars are made cleaner, the growth imperative may lead to an increase in sales, making the net result for the environment negative. Moreover, consumers may be tempted to drive a clean car more often, further increasing the negative environmental and health impacts.*

*If citizens decide to share cars, access to function (mobility) replaces ownership of a product (car) while and a lot less resources for producing cars are required. Without a car sitting in their driveway, people drive less often. A further step is if e.g. teams of families in a neighbourhood agree with a local farmer to bring their baskets of fresh produce weekly. The mobility function is still guaranteed (bridging the distance between families and food) while the ecological impact is drastically reduced. These **social** innovations have a much larger impact than clean technology as such. If they are generalised (e.g. by **government** support), this will force car companies to develop innovative business models.*

In (socio-economic institutions of) the current industrial regime, functions are mostly organised in silos with specific goals and means. The function of ‘transport’ e.g. is translated into ‘things’ like roads, harbours, a logistics sector or car industry requiring growth etc. In terms of function, however, transport could mean ‘the capacity to bridge the distance between people and what they need with low entropy’. Urging the car industry to sell cleaner cars is not functional as (without financial innovation) more cars have to be sold. If however twenty families share a car, access to function is offered with less resource. Civil Society Organisations (CSO’s) that ask a local farmer to bring baskets of food to the community once a week increase prosperity (more free time, less cars) and lower entropy. If participants in these communities are rewarded with (local money allowing them to buy) train tickets, functionality goes up again including

people in poverty. Technology combined with sustainable entrepreneurship can create ICT-tools to facilitate access or develop renewable and democratically accessible products or tools. Economic RRI studies how goods and services can be made available without urging companies to accumulate capital (P2P, Economy of communion...), how community currencies can strengthen local economies or what indicators are needed to monitor regrowth in a complex context. For the commons economy to upscale this expertise must be made available to all by CO-RRI hubs exchanging knowledge.

A company specialised in retrieving metals from mobile phones depends on citizens recycling. As long as people do not bring their old phones back, its technology is powerless, and the phones end up in third world countries where they create serious health dangers. Current economic infrastructure ('the economy') has mechanisms for spreading the phones (increasing entropy) at growing rates (marketing, quick upgrading of models, advertisements...) but lacks mechanisms for recollecting them. So economic and monetary innovations are needed, such as leasing the phones (giving the citizen a strong incentive to bring it back to the leasing company when it is no longer in use) or paying them with a local currency when they bring it to the recycling site. Citizens are thus no longer just consumers of products, but they contribute (secondary raw materials) to the (circular) production process and become 'prosumers'. This requires adaptation of legislation on consumer protection.

CO-RRI hubs mediate between specialist R&I institutions and 'real life labs' at the level of cities or CSO's by providing methodological frameworks that focus on socioeconomic functions, allowing them to map in a transdisciplinary way leverages needed to upscale emergent solutions. They integrate social, economic-monetary and technological leverages into new governance models and paradigms. By sharing their methods and results, they foster the uptake of CO-RRI for transitions at regional, national and transnational scales.

Table 1: Stakeholder analysis for CO-RRI-hubs

Positive power = leverage for systemic impact	high	Pioneers in regime/expert institutions <ul style="list-style-type: none"> - Academic sustainability research - Legal experts in sharing economy - Circular economy, biomimicry R&I... - Benefit corporations, Economy of Communion Movement, Social Stock Exchange, Business for Good... <p>→ Partners for knowledge co-creation</p>	CO-RRI local hubs (with regional clusters & www-platform) mediating between Real life labs and Pioneer experts
	low	Financial growth oriented (in regimes and niches) <ul style="list-style-type: none"> - Classical for-profit companies - Technological innovation for growth - 'Sharing' companies to raise 	Real life labs <ul style="list-style-type: none"> - CSO's Transition Towns, Ecovillages, Local Exchange and Trade Systems, Repair Cafés... - Cities (Ville Ravie, Green, Sharing,

		private profit (e.g. Uber, AirBnB...) → Invited and encouraged to contribute their knowledge and infrastructure to the common goal	Ecocity...) - Prosumers (Community Supported Agriculture, Car sharing initiatives, Cohousing projects...) → Partners for knowledge co-creation
		Low	High
		Innovative potential = Capacity for shifting paradigm towards common good & regrowth	

10 CO-RRI development – prototype and next steps

The development of local CO-RRI-hubs is the aim of the FoTRRIS project. A baseline-prototype for CO-RRI-hubs is proposed that will be tested in five case studies. The following features define the prototypes.

1. A CO-RRI-hub has its own specific infrastructure that is accessible to communities and has a low threshold for citizens, CSO's, companies and local authorities. Commons innovators and specialist researchers are recognised as co-experts for CO-RRI and their work is valorised accordingly.
2. A CO-RRI-team consists of three people minimum, all of whom are familiar with systems thinking. Their roles are to:
 - a. Translate a problem into a (broad, inclusive, sustainable) goal in terms of (access to) functions for the whole community while keeping entropy low;
 - b. Bring together relevant actors from niches (real life labs) as well as pioneers in specialist institutions, imply them in RRI to co-create knowledge and catalyse change
 - c. Facilitate a (series of) workshops mapping current lock-ins and needed leverages for niches and regimes to work together towards the chosen goal, combining social with technical and financial innovation and policy recommendations (prototype: MISC-methodology)
 - d. Communicate the results with society, the media and with people or institutions with high leverage (political decision-makers, providers of financial support, networks of pioneers in the business and academic world).
 - e. Record the processes and results of their cocreative actions and build a common stock of expertise at national and international level (using the platform developed by FoTRRIS).
3. Each CO-RRI-hub shares its methodology, tools and results under a creative commons licence (or open source). It disseminates its results using the FoTRRIS-platform and other media that reach the local community. CO-RRI-hubs exchange results with each other and thus feed the development of collective knowledge on (required) high level leverages (legislation, financial innovation, national or European institutions...). They pool resources to make knowledge on high level leverages available for all CO-RRI-hubs.

Ad 1. In the prototyping phase (during the FoTRRIS project), a space may be made available by stakeholders (local business, community centre, adult education initiative...). The FoTRRIS consortium will establish contacts with actors that may support the creation of a more permanent hub. Appropriate valorisation systems for participants will be explored.

Ad 2. During the prototyping phase these roles are assumed by persons connected to the FoTRRIS consortium; each partner will search means to establish a local CO-RRI-hub with a permanent team, developing an appropriate business model pooling resources of the local community.

Ad 3. The FoTRRIS-project develops an online platform that allows CO-RRI-hubs to share tools and results. Means to continue running this platform after the end of FoTRRIS will be sought.

End notes

ⁱ Roddier, F. (2016), *Thermodynamique de l'évolution. Un essai de thermo-bio-sociologie*. Artignosc-sur-Verdon : Editions Parole.

ⁱⁱ S.A. (2016). Let reason prevail. *Nature* (vol. 538), 20/10/2016, p. 289.

ⁱⁱⁱ Snick, A. (2016a). New paradigms for European Security. Reaction to I. Krastev & J. Frank. *International. Zeitschrift für internationale Politik* 1/2016, 25-27.

^{iv} Watzlawick, P., Weakland, J.H. & Fish, R. (1974). *Change. Principles of problem formation and problem resolution*. New York – London: Norton.

^v Kuhn, T. (1996). *The structure of scientific revolutions*. Chicago – London: Chicago University Press. (1962 1st ed.).

^{vi} Benyus, Janine (1997). *Biomimicry. Innovation inspired by nature*. New York: HarperCollins Publishers.

^{vii} Ulanowicz, R. (2015). *Process Ecology: philosophy passes into praxis*. <https://www.ctr4process.org/whitehead2015/wp-content/uploads/2014/06/PhilPrax.pdf>.

^{viii} Sverdrup, H. & Ragnarsdottir, K.V. (2014). Natural resources in a planetary perspective. *Geochemical perspectives* 3, nr 2.

^{ix} Goerner, S., Lietaer, B. & Ulanowicz, R. (2009). Quantifying economic sustainability. Implications for free enterprise theory, policy and practice. *Ecological economics* 69, 76-81.

^x Troncoso, S. & Utratel, A.-M. (Eds). (2015) *Commons transition. Policy proposals for an open knowledge commons society*. Amsterdam: P2P Foundation.

^{xi} Snick, A. (2016b). Is a different kind of currency possible? *Politique Internationale* 151 – Special issue 'Of money and men', 55-62.

^{xii} Lietaer, B., Arnsperger, C., Goerner, Sally & Brunnhuber, S. (2012). *Money and sustainability: the missing link* Axminster: Triarchy Press.

^{xiii} In 2016 Earth Overshoot Day landed on August 8, 'marking the date when humanity has exhausted nature's budget for the year. For the rest of the year, we will maintain our ecological deficit by drawing down local resource stocks and accumulating carbon dioxide in the atmosphere.' Source: http://www.footprintnetwork.org/en/index.php/GFN/page/earth_overshoot_day/. So in eight months we consume what the planet can only provide every twelve months.

^{xiv} Janez Potočnik (UNEP International Resources Panel) describes two aspects of decoupling. Resource decoupling happens when resource productivity is improved at a rate that is faster than the economic growth rate. So increased economic value (and possibly a greater level of well-being) can be created by using the same or a smaller *amount of resources*. Impact decoupling refers to achieving more well-being (and if necessary economic growth) with fewer *negative environmental impacts* or even restoration of ecosystem services (*Aurelio Peccei Lecture 'The new economic model. Circular economy and decoupling'*, Brussels: Club of Rome-EU Chapter, 12/04/16). However, pooling resources, when used as a tool to increase private profits, leads to new business models that evade current social legislation and entails new forms of exploitation.

^{xv} Sapolsky, R. (2011). *Chaos and reductionism*. https://www.youtube.com/watch?v=o_ZuWbX-CyE.

^{xvi} Surowiecki, J. (2004). *The Wisdom of Crowds: Why the Many Are Smarter Than the Few and How Collective Wisdom Shapes Business, Economies, Societies and Nations*, New York: Anchor House.

^{xvii} Ostrom, E. (1990). *Governing the commons. The evolution of institutions for collective action*. Cambridge: University Press. Today a large number of resilient initiatives at city or community level are emerging, both bottom-up (e.g. Transition Towns) and supported by innovation policies at national or international level (e.g. Covenant of Mayors, JPI Urban Europe).

^{xviii} See for example the International Association for the Study of the Commons: <http://www.iasc-commons.org/>

^{xix} Orsi, Janelle (2012), *Practicing law in the sharing economy. Helping people build cooperatives, social enterprise, and local sustainable economies*. Chicago: American Bar Association Publishing.