Everard, M. and Longhurst, J.W.S. (in press). Reasserting the primacy of human needs to reclaim the 'lost half' of sustainable development. *Science of the Total Environment*, STOTEN-D-17-07197R1.

Reasserting the primacy of human needs to reclaim the 'lost half' of sustainable development

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Abstract

The concept of sustainable development evolved from growing awareness of the interdependence of social and economic progress with the limits of the supporting natural environment, becoming progressively integrated into global agreements and transposition into local regulatory and implementation frameworks. We argue that transposition of the concept into regulation and supporting tools reduced the focus to minimal environmental and social standards, perceived as imposing constraints rather than opportunities for innovation to meet human needs. The aspirational 'half' of the concept of sustainable development specifically addressing human needs was thus lost in transposing high ideals into regulatory instruments. The Sustainable Development Goals (SDGs) restore focus on interlinked human needs, stimulating innovation of products and processes to satisfy them. Through three case studies – PVC water pipes, river quality management in England, and UK local air quality management – we explore the current operationalisation of the concept in diverse settings, using the SDG framework to highlight the broader societal purposes central to sustainable development. Partnerships involving civil society support evolution of regulatory instruments and their implementation, optimising social and ecological benefits thereby serving more human needs. Restoring the visionary 'lost half' of sustainable development – meeting human needs in sustainable ways – creates incentives for innovation and partnership; an innovation framework rather than a perceived constraint.

Research highlights

The aim of sustainable development to address human needs may be lost in execution

The Sustainable Development Goals restore the focus on addressing human needs

Three case studies illustrate variably successful examples of implementation

Partnerships between regulators and civil society help retain a focus on human needs

New regulatory models must address meeting human needs sustainably driving innovation

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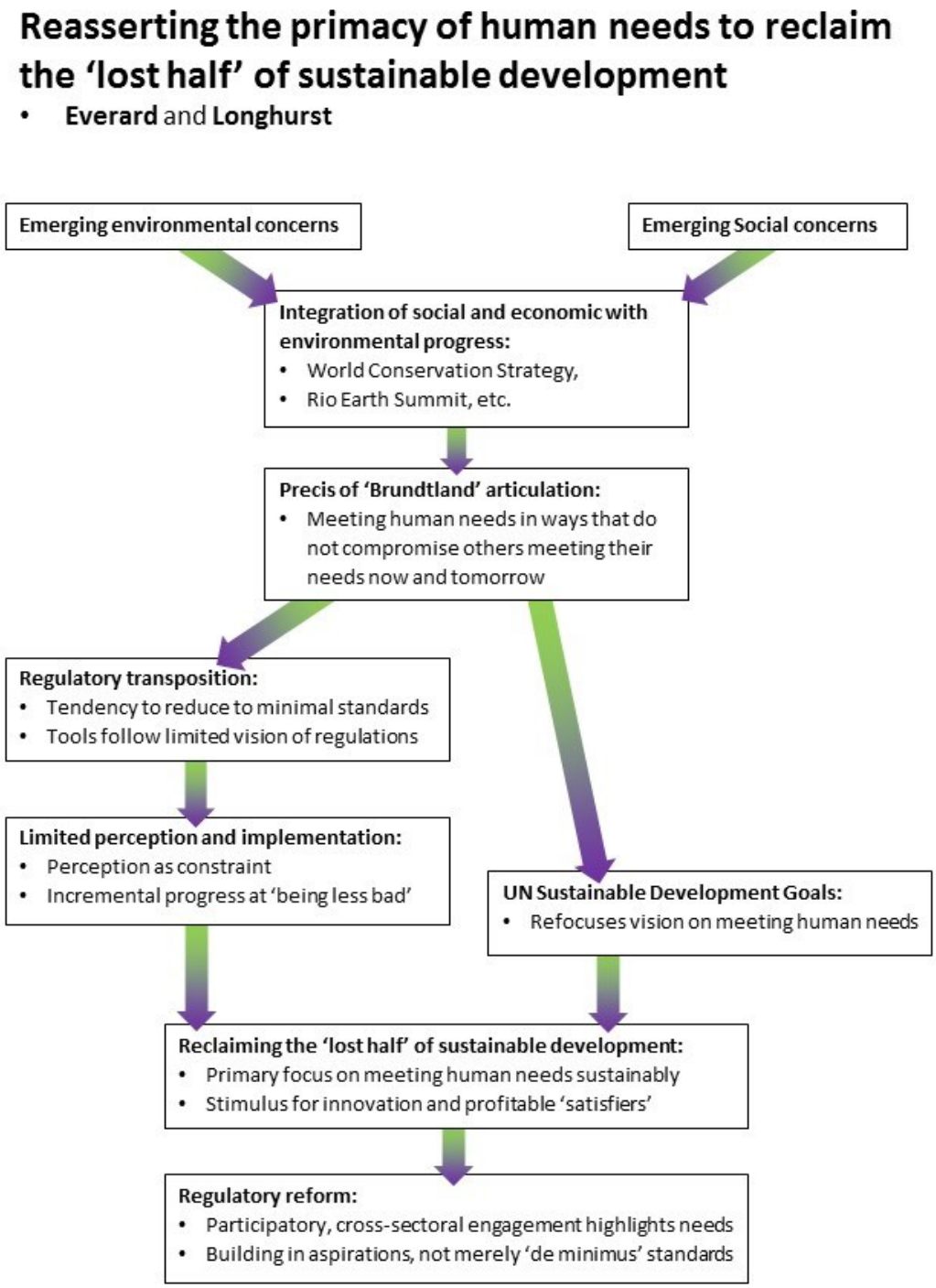
Keywords

Sustainable Development Goals; vision; human needs; corporate responsibility; business; regulation

Graphical abstract



1. Introduction

The contemporary concept of sustainable development evolved progressively from growing awareness of the interdependence of social and economic progress with the supporting environment. The concept of sustainable environmental management significantly predates this, for example in considerations of mineral and energy resource management (e.g. Zimmerman, 1933), in the balancing of exploitation with regeneration under sustainable forest management practices developed during the seventeenth and eighteenth centuries in Europe (Grober, 2007; Blewitt, 2015), and uptake into policy of Maximum Sustainable Yield (MSY) in fisheries since the 1930s (Russell, 1931; Graham, 1935). Contemporary concepts underpinning sustainable development received international recognition in 1972 at the UN Conference on the Human Environment when the international community agreed that human development and the environment should be managed in a mutually beneficial way rather than as separate issues (United Nations, 1972). Applied in a more general context, the Club of Rome's report *Limits to Growth* (Meadows *et al*., 1972) included one of the first instances of the word 'sustainable' in its contemporary sense, seeking "…*a model output that represents a world system that is sustainable without sudden and uncontrolled collapse and capable of satisfying the basic material requirements of all of its people*" (Meadows *et al*., 1972). The complete term 'sustainable development' entered the common lexicon in 1980 with publication of the World Conservation Strategy (IUCN, 1980).

Further evolution of the concept culminated in 1987 with the UN's report *Our Common Future* (World Commission on Environment and Development, 1987), also known as the 'Brundtland Report', which introduced its most widely recognised and consensual definition: "…*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*". The 'Brundtland Definition' integrates a number of important strands including: a basis in fulfilling human needs now and into the future; recognition that current means by which needs are addressed can limit future opportunity; and, consequently, a powerful commitment to intergenerational equity (e.g. Gibbs *et al*., 1998; Hopwood *et al*., 2005; Holden *et al*., 2014).

Johnston *et al*. (2007) noted that 'sustainable development' had suffered a proliferation of new definitions, many weakening the tight interlinkage between human wellbeing and the environment such that the concept increasingly became diluted and malleable to justify a wide range of vested interests. This dilution of original meaning limited its credibility, arguably also limiting its utility to progress the interlinked environmental and socio-economic developments it was designed to underpin. Reviewing the diverse manner in which the concept of sustainable development had developed, Johnston *et al*. (2007) argued the case for a robust and objective, scientifically rooted set of conditions to define and test sustainability, highlighting The Natural Step (TNS) model developed in Sweden in the early 1990s. The TNS model is based on thermodynamic and other non-contested principles, and serves to reclaim the definition of sustainability through unambiguous, replicable principles guiding developments in political instruments and public policy and corporate decision-making.

New or amended definitions of sustainable development have continued to proliferate, and regulatory instruments and management tools have increasingly sought to integrate the concept into operational norms. National strategies seeking to embed sustainable development into legislation, including for example the UK's HM Government (1990 and 1994), are not without practical difficulties. The UK Government's most recent sustainable development strategy (HM Government, 2005) sets out five 'guiding principles': living within the planet's environmental limits; ensuring a strong, healthy and just society; achieving a sustainable economy; promoting good governance; and using sound science responsibly. Translating those broad aims into practical

legislation and operational tools presents significant challenges, as much for remaining true to underpinning principles as to the nature of regulation itself (Godschalk, 2004). One problem associated with regulation has been its primary focus on regulatory standards, comprising benchmarks promulgated to enforce legislative provisions. Many regulations require baseline minima of environmental emissions, as for example under Integrated Pollution Prevention and Control (IPPC) (EU, 2008), in practical tools supporting regulatory requirements such as Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA), and within management protocols such as Environmental Management System (EMS), the ISO 14001 for environmental management systems (British Assessment Bureau, 2016) and the Global Reporting Initiative (GRI, 2017). Development of environmental performance metrics provides a structured basis for planning progress with the broad aims of sustainable development (Phillips, 2011). However, baseline metrics alone do not embody the aspirations articulated by the Brundtland Definition concerning the meeting of human needs now and tomorrow, instead promoting incremental improvement rather than driving the magnitude of innovation and socio-technical change required to meet the wider vision implied by sustainable development (Mulder, 2007). In essence, a regulatory standards approach in isolation serves to establish acceptable performance minima whilst generally failing to motivate progress towards innovation that meets human needs.

Corporate perceptions, tools and behaviours are understandably shaped by meeting regulatory requirements. However, if framed as regulatory minima, these will tend to distort understanding of sustainable development, framing it as a constraining set of obligations rather than a linked set of principles enabling the co-benefits of environmental and human wellbeing to be identified. There is then a corporate and wider public disconnection from the primary aspirational purpose of addressing the meeting of human needs, now and into the future. A focus on human needs and human-scale development is necessary to allow the connections between, and the innovation of tools, shifts in policy and practice, necessary to secure or advance human wellbeing whilst simultaneously conserving or enhancing the natural environment (Gough, 2015; Guillen-Royo, 2015; Holden *et al*., 2017). Refocusing on addressing needs is also a spur for technical and social innovations, including development of new products and activities with long-term profitability (Agola, 2016). Arguably, the aspirational half of the narrative of sustainable development – meeting human needs – has to date been lost in transposition of high ideals into regulatory instruments.

The study of human needs has a long history. The work of Maslow (1943 and 1954) in identifying a 'hierarchy of human needs' was seminal, augmented by Max-Neef *et al*. (1989) who recognised that a range of 'satisfiers' (physical things, settings, qualities and actions) was necessary to fulfil these needs. In essence, physical products (roofs for shelter, pipes for conveyance of clean water and sanitation, etc.) and practical management actions are significant elements of what is necessary to satisfy needs.

The UN's consensual 17 Sustainable Development Goals (SDGs) (United Nations, 2016) make a welcome addition to considering the limitations in what had become an accepted sustainable development narrative. The SDGs succeed in refocussing attention on a linked set of human needs aimed at, as UNDP (2015) puts it, "*Meeting citizens' aspirations for peace, prosperity, and wellbeing, and to preserve our planet*". The vision of sustainable development then elevates from satisfying minimal and constraining regulatory performance criteria towards how to meet a diversity of human needs with appropriate 'satisfiers' on a sustainable, or increasingly sustainable, basis. The SDGs have to be understood in a systemic context, addressing all goals as an inherently interconnected set. It would be easy but limiting for a company, value chain or other institution to fall into the trap of selecting just a few goals in a given sector, such as a business recognising responsibilities only to 'decent work and economic growth' (SDG8) and 'industry innovation and infrastructure' (SDG9). This 'siloed' approach misses the systemic framing of the SDGs. Rather, all SDGs should be considered as an interconnected, intimately interdependent suite, from which innovative

opportunities may arise. The SDGs also provide a framework for assessment of progress towards a more sustainable future.

Three examples of translation of high-level sustainable development principles into operational instruments are described, drawing out shortfalls but also generic lessons for future evolution of tools that seek to reclaim this aspirational 'missing half' of sustainable development.

2. Selection and outline of case studies

Three case studies have been selected to illustrate a spectrum of successful and less successful examples of embedding of the core principles of sustainable developing into operational practice. In each case study, translation of high-level sustainable development principles into operational instruments is discussed and generic lessons identified. The case studies have been selected to represent the challenges presented by scale, both spatial and temporal, in establishing satisfiers of human needs. Through an exploration of the relationship between the case studies and the suite of SDGs, the paper seeks to reclaim the 'missing half' of the original vision of sustainable development.

2.1 Contrasting statutory and voluntary initiatives in the European vinyl industry

This first case study addresses the polyvinyl chloride (PVC or vinyl) business sector in Europe. It considers the role of established legislation and management tools governing the chemicals sector, contrasting these with a parallel, established voluntary, industry-driven initiative seeking to achieve sustainability. Largely due to its adaptability, low cost, chemical resistance, durability and inherent recyclability, PVC (also known as vinyl) is today the world's third largest-selling plastic (Reliance Industries Limited, 2014).

The EU REACH framework (EC, 2006 1907/2006) provides the regulatory framework for the European chemicals industry. The purpose of REACH is to improve the protection of human health and the environment through the better and earlier identification of the intrinsic properties of chemical substances through four processes (registration, evaluation, authorisation and restriction of chemicals) under the authority of the European Chemicals Agency (ECHA). Constituent chemicals used or imported into the EU in excess of a threshold annual imported or manufactured volume, related to degree of chemical concern, are assessed on the basis of potential hazard, rather than risk. Chemical safety assessment of a substance under REACH includes: (a) human health hazard assessment; (b) physicochemical hazard assessment; (c) environmental hazard assessment; (d) persistent, bioaccumulative and toxic (PBT) and very persistent and very bioaccumulative (vPvB) assessment. A narrow focus on potential hazard overlooks life cycle risks of compounded substances and products. This includes impacts of mixtures of chemicals in the environment (Backhaus *et al*., 2010), but also the mobility of constituent chemicals in closed applications (such as intermediate chemical processes) and when compounded into end-user products (BiPRO, 2015). Understandably, chemical assessment tools have followed the lead of the overriding regulatory framework. For example, Life Cycle Assessment (LCA) and Environmental Product Declarations (EPD) incorporate criteria such as toxicity, global warming and eutrophication potential, relating to potential for adverse impacts. The focus in the chemicals sector is upon the adverse potential impacts that chemicals may have on the environment and human health, simplistically addressed as potential hazard rather than risk in a stewardship and product life cycle context (Pennington *et al*., 2006). Though it remains important to identify and reduce negative impacts of chemicals, the focus on their potential roles as constituents of products meeting human needs, for example in provision of low-cost, adaptable, durable and recyclable water pipes, shelter, agricultural innovations and other tools enhancing the meeting of human needs (Everard, 2017), has been lost in regulatory transposition.

In the 1980s and 1990s, the PVC industry had a poor environmental reputation, in part due to lax practices but also related to its association with chlorine chemistry. The voluntary ban on the use of PVC in all applications other than cables introduced by the multinational IKEA in 1991 (IKEA, 2017) was one of many high-profile retailer decisions placing pressure on the whole PVC value chain in Europe. Forced to address its future survival, the UK PVC Industry came to recognise that sustainable development was fundamental to the survival of a business sector under intense NGO and media pressure (Everard, 2008). The Natural Step (TNS) was asked to apply its science-based framework to: (1) address the current state of sustainability of the industry and its products; (2) whether progress was being made towards sustainability; and (3) the steps necessary to engage seriously with sustainable development, leading to the identification of five sustainability challenges for PVC (Everard *et al*., 2000) reproduced in Table 1. Through a long evolutionary process (summarised by Leadbitter, 2002 and Everard, 2008), this science-based TNS approach became progressively accepted and actively engaged with initially across the UK with the former Hydro Polymers taking a leading role in innovation and open reporting (ENDS, 2003). Voluntary commitment to sustainable development, both as a defensive measure to avert product deselection but also as spur for securing markets based on the positive contributions of PVC across a range of societal sectors, was subsequently taken up across the European PVC value chain, now underpinning the five voluntary commitments under the umbrella body VinylPlus spanning the EU-28 Member States (http://www.vinylplus.eu/) (Figure 1).

Table 1: The five TNS sustainable development challenges for PVC

1. The industry should commit itself long term to becoming carbon-neutral
2. The industry should commit itself long term to a controlled-loop system of PVC waste
3. The industry should commit itself long term to ensuring that releases of persistent organic compounds from the whole life cycle do not result in systemic increases in concentration in nature
4. The industry should review the use of all additives consistent with attaining full sustainability, and especially commit to phasing out long term substances that can accumulate in nature or where there is reasonable doubt regarding toxic effects
5. The industry should commit to the raising of awareness about sustainable development across the industry, and the inclusion of all participants in its achievement

Figure 1: The five voluntary commitments of VinylPlus (©VinylPlus)

[Note to reviewers: This image is reproduced here to aid reviewing. Top copy of image is file *Fig 1 - VinylPlus five challenges graphic.jpg*, supplied separately]

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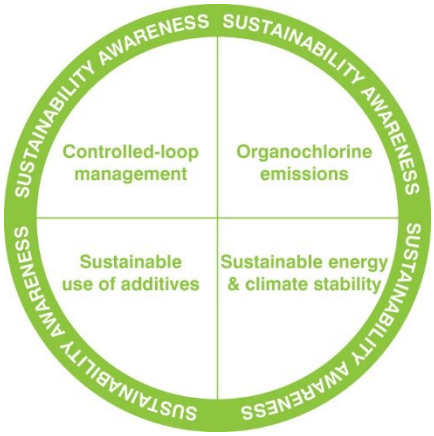
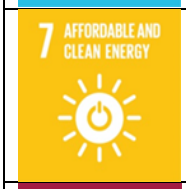


The 'five challenges' (as originally published by TNS or in their modified VinylPlus form) provide a shared, science-based platform for sector-wide environmental improvement and its contribution to meeting needs that can be understood and integrated between different businesses in the value chain. The emphasis of innovation shifts from simple hazard assessment towards risk-based sustainable use across the full societal life cycle, of the PVC polymer and its many additives, including post-use and recovery. The introduction of the SDGs, to which contributions linked to the five sustainability commitments are identified by VinylPlus (2017), further raises that vision towards the role that the PVC industry and its products can serve to contribute to the meeting of a diversity of human needs on a sustainable basis. This creates space and motivation for innovation relating to the meeting of human needs that is absent from the environmental improvement constraints of traditional regulatory approaches and tools, recognising the potential for new product development and sustainable profit if the SDGs are considered as a linked suite. Table 2 describes potential positive contributions of PVC water pipes to addressing human needs, primarily considered in a developing world context, through the lens of the SDGs generating potential societal benefits and, in this case study, also the PVC value chain as a provider of 'satisfiers' (summarised from Everard, 2017).

Table 2: Contribution of PVC water pipes to addressing the seventeen UN SDGs

Sustainable Development Goal	Potential contribution of PVC water pipes
	• Indirect contribution through improved provision of clean water supplies (SDG6), also enhancing food production (SDG2) and health outcomes (SDG3) and liberating vulnerable people from the drudgery of water-gathering (particularly SDG5 as women are often the primary natural resource stewards) to enabling them to engage in productive activities
	• Indirect contribution from more stable and safe water supply (SDG6), and more efficient uses of water such as trickle irrigation in arid environments (Sharma and Everard, 2017), collectively supporting improved food productivity
	• Direct impact through safe provision of water in proximity to homes. Also Indirect impacts through enhancing food security (SDG2) and reductions in female risk and drudgery (SDG5)

	• Indirect impact through liberation of children from shared female drudgery of water gathering frees them for education, with liberated women taking leading roles as educators
	• Direct impact through provision of clean water in developing countries, which can significantly reduce the drudgery of women (often serving and primary natural resource stewards) who might otherwise spend 6-7 hours a day fetching water of dubious quality and at personal risk
	• Direct impact through the provision of improved piped water and sanitation
	• An innovative direct contribution of PVC water pipes to this Goal is seen, for example, in the role of transparent PVC pipes in algal bioreactors, products from which have the potential to produce biodiesel (Hincapie and Stuart, 2015; GF Piping Systems, 2017).
	• Direct impact, where responsible businesses supplying PVC pipes have strong regard to decent work and economic growth
	• Direct impact though the manufacture and management of PVC water pipes thereby making a contribution to industry innovation and infrastructure
	• Indirect impact though provision of clean water delivery infrastructure, at low cost and with adaptable products making this benefit available to more in society
	• Direct contribution, as durable and adaptable PVC water pipes provide infrastructure vital for the sustainability of cities and communities
	• Direct contributions when the PVC industry takes responsibility for product life cycles, particularly the TNS/VinylPlus challenge of controlled loop recycling as a key example of responsible consumption and production
	• Indirect impact through the lower embedded carbon content and inherent recyclability of PVC compared with other pipe materials, and particularly where PVC is recycled further substantially reducing its carbon footprint relative to virgin materials
	• Indirect contribution through greater efficiency of potable and waste water handling

	• Indirect contribution through greater efficiency of potable and waste water handling
	• Supporting contribution through the role of improving water management in a more secure and equitable world
	• Indirect contribution as international collaboration in the PVC value chain can contribute to partnerships for the goals

As the example of PVC water pipes in a developing world context demonstrates, application of a single material and industry sector can make a spectrum of direct, indirect and supporting contributions to addressing all SDGs. Some may be self-beneficial in identifying new profitable markets serving consensual needs. The same principle of systemic vision, engagement, differential contributions and potential opportunities across the seventeen SDGs applies to all other PVC applications (wiring, building materials, shelter, medical and many more) and other materials, businesses, and societal sectors.

Factors underpinning the TNS sustainability challenges and VinylPlus commitments – carbon and climate change; controlled loop; releases of persistent substances; sustainable use of additives; and engagement of the whole societal value chain – are unlikely to be resolved in the short to medium term. Indeed, they are increasingly pressing as the global human population grows, becomes more urbanised and grapples with meeting its needs from a dwindling natural resource base. The principle of meeting more human needs with less physical resource will therefore continue to impinge on global society, and to frame business opportunities for satisfying needs in the safest, cleanest and most efficient way. The SDGs serve to elevate the purpose of the PVC value chain beyond merely environmental improvement, but rather addressing human needs in the most sustainable way. It also provides an objective framework for comparison or innovation of all materials and products in terms of their potential contribution to meeting human needs sustainably.

This change in emphasis towards human needs calls for a more integrated approach to regulation factoring in the optimally sustainable meeting of human needs, rather than simple imposition of new performance minima. Audited progress made under the EU-wide VinylPlus voluntary commitment is a flagship for serious engagement with sustainable development. The role of VinylPlus in addressing partnerships for the SDGs is recognised by the UN (United Nations, 2017), with UNIDO (the European Union United Nations Industrial Development Organization) outlining the contribution of the European PVC industry to "*…the 'less is more' vision through its greater durability, longevity and recyclability in materials used in future urban developments*" (Yvetot, 2017). Contextualising these aspirations towards sustainability within the SDGs provides the value chain with the formerly missing element and higher purpose of demonstrably making contributions to sustainably satisfying human needs.

2.2 Contrasting statutory and voluntary initiatives river quality management in the UK

The regulation of river quality in the UK has moved through multiple phases. Up to the 1970s, the primary focus was on sources of pollution, with a particular emphasis on industrial discharges and

sewage treatment works. From the 1970s onwards, emphasis shifted to the quality of the receiving waters, with the setting of River Quality Objectives (RGOs) forming a basis for determining discharge consents, monitoring compliance and planning improvements (National Rivers Authority, 1994). This marked a transition from source of pollution to 'use-related' standards. RQOs were initially framed on a series of five chemical National Water Council (NWC) classes, superseded by the River Ecosystem (RE) classification scheme in 1994 addressing Biochemical Oxygen Demand (BOD), ammonia, dissolved oxygen, un-ionised ammonia, pH, hardness, dissolved copper and total zinc determinands reflecting the requirements of different quality levels of river ecosystem (data.gov.uk, 2017). Compliance with RQOs was based on mean values from twelve monthly samples. The RQO scheme ceased at the end of 2006.

Regulatory focus evolved with introduction of the EU Water Framework Directive (WFD) (EU, 2000) in 2000. The end-point of the WFD rests not with the source of quality deterioration nor identified uses of the receiving water, but instead on the achievement of 'Good Ecological Quality' (or Good Ecological Potential where overriding economic factors prevent meeting Good Ecological Quality) of designated Water Bodies assessed across a range of chemical, biological and hydromorphological parameters. The WFD extends to fresh surface and groundwater, inshore and transitional waters. Achievement of Good Ecological Status (or Potential) depends not merely on traditional approaches to treatment of point sources of effluent, but a far more integrated approach to catchment management (Defra, 2013). Over the same timeframe as these changes in focus and regulatory end-point of river management, there were also growing requirements on water service companies and other large businesses discharging liquid effluent to pay greater regard to climate-active gas emissions arising from wastewater treatment (OFWAT, 2010).

Notwithstanding progressive transition from pollutant source to overall ecological quality in driving EU legislation, practical implementation of the WFD in the UK tended to revert to compliance with quality classes, many of them like those used in the RQO system though with additional parameters such as some biological categories and hydromorphological condition. This narrow focus on compliance with classification schemes failed to embody the WFD's systemic intention and methodological approach (Voulvoulis *et al*., 2017) including omission of engagement and collaboration between public bodies, local people and communities to achieve outcomes of clear benefit to all parties (Daly *et al*., 2016). Public understanding of the intended ecological status outcomes of the WFD was limited, though the language of 'ecosystem services' could offer a useful medium to communicate how improvements in aquatic ecosystem health generate multiple, widely appreciated societal benefits (Everard, 2012) and provide a broader basis for assessing costs and benefits (Vlachopoulou *et al*., 2014).

The implementation gap created by perpetuating a former narrow focus on regulatory criteria thwarted the systemic intent of averting degradation and protecting human benefits. Consequently, despite a substantial and unprecedented body of legislation relating to river quality, public perception that an holistic regard for the river and adverse trends in the quality of certain taxa, particularly of migratory fishes integrating pressures across whole catchments in completion of their life cycles, was a spur for the genesis of the UK's now pervasive, widely supported and influential Rivers Trust movement (Stollard and Rickard, 2005). The UK's Rivers Trust civil society movement has subsequently evolved and spread across the country, proving influential in integrating the efforts of existing statutory bodies and non-statutory community-based catchment management groups and to seek effective management of problems with rivers, informed by local knowledge and context and achieved by public participation, collaborative working and decentralised modes of assessment, planning and decision-making (Cook *et al*., 2012). This has not only improved progress with implementation of the WFD, but also filled a democratic gap in transposition of the Directive into the UK that had formerly overlooked the public participation requirement. This in turn has led to co-learning between statutory and non-government actors, the successes of the participatory approach directly informing the UK Government's Catchment-based Approach (CaBA) policy to

relocate debate, decision-making and action about the future direction of improvements to the water environment more locally (Defra, 2013). The CaBA embeds collaborative working at a river catchment scale to deliver cross-cutting improvements to the water environment, and is active in the 100+ WFD catchments across England including those cross-border with Wales, engaging with more than 1,500 organisations and addressing multiple benefits ranging from flood risk to water quality, biodiversity and climate change (CaBA, 2017).

The evolution of river quality management thus represents a successful model of transition from problem characterisation and reaction towards a stakeholder based mission to address locally identified needs spanning multiple, formerly fragmented disciplines. Table 3 addresses direct and indirect contributions of the transition on river quality management in England to the seventeen UN SDGs.

Table 3: Contribution of the transition on river quality management to the seventeen UN SDGs

Sustainable Development Goal	Contribution of river quality management
	• No direct impact
	• No direct impact
	• Direct contribution to human wellbeing through reduced pollutant loads in rivers
	• Direct contributions have been achieved through public engagement and devolved river management particularly under the Catchment-based Approach (CaBA), some explicitly focused on both formal and informal learning outcomes
	• No direct impact
	• Significant direct benefits arising from cleaner water for abstractive and other uses of rivers, as well as improvements in wastewater management to achieve required standards
	• Indirect contributions the role of progressive rounds of water investment agreements requiring water service companies to take greater account of their climate active gas emissions (OFWAT, 2010), potentially stimulating progress with renewable energy use and generation

	• Modest indirect impact via stimulation of market for greener technologies
	• Modest indirect impact via stimulation of market for greener technologies
	• Direct contribution as, across England, there is a clear pattern of inequality in people's proximity to rivers with good and bad biological water quality. There is clear and consistent correlation between people living in deprived neighbourhoods poor river quality within 600m of where they live, as well as between less deprived populations in proximity to a good quality river (Damery *et al.*, 2008)
	• Direct contribution as many of the deprived neighbourhoods in proximity to poor river water quality are urban (Damery *et al.*, 2008), efforts to achieve Good Ecological Status contributing to enhanced natural infrastructure in all communities
	• Indirect contribution as the emphasis of catchment management for Good Ecosystem Quality emphasises the range of potentially deleterious activities spanning urban, industrial and rural sectors, potentially creating an indirect driver for more responsible production
	• Direct contribution as (noted under SDG7) progressive rounds of water investment agreements have required water service companies to take greater account of their climate active gas emissions (OFWAT, 2010), driving positive climate action
	• Indirect contribution as, although SDG14 focuses primarily on 'oceans, seas and marine resources', these waters are receptors of the impacts of river quality; the WFD also applies to coastal and transitional waters
	• Direct contribution through the catchment-scale focus of management to achieve Good Ecological Quality under the WFD, creating incentives for improved management of terrestrial ecosystems
	• Supporting role where improved river quality occurs across a region
	• Direct contribution as the WFD operates across Europe, with many co-development and collaborative initiatives entailed in development of standards, interpretations and appropriate 'Programme of Measures' responses to its requirements

2.3 The Local Air Quality Management framework in the UK

The Air Quality Management framework in the UK implements a range of EU Directives. Significant amongst these is the Ambient Air Quality Directive 2008/50/EC (EC, 2008), amalgamating Framework Directive 96/62/EC on ambient air quality assessment and management

(http://ec.europa.eu/environment/air/quality/legislation/existing_leg.htm) and a series of associated Daughter Directives serving to control levels of specific pollutants, and to establish monitoring procedures, methods of measurement and calibration in order to achieve comparable measurements throughout EU Member States. Commencing in the mid-1990s, the UK evolved a management system for local air quality to complement national actions. This case study considers the local elements of the UK approach, whilst noting the parallel EU-mandated regulatory requirements. The UK's Local air Quality Management (LAQM) approach has its origin in the requirements of the Environment Act 1995, which mandated the establishment of a process for identifying and remediating areas of poor air quality and requiring the publication of a National Air Quality Strategy (NAQS) (Longhurst *et al*., 1996; Longhurst *et al*., 2009).

The first NAQS for England, Scotland Wales and Northern Ireland, *The United Kingdom National Air Quality Strategy* (Department of the Environment, 1997), was published in March 1997. It set out a range of requirements upon local authorities, the Environment Agency, and the devolved administrations. Government commitments in implementing these requirements include the use of sound science, and the precautionary, polluter pays and sustainability principles. The principal focus of the 1997 NAQS was the setting of health-based standards for eight pollutants (Beattie *et al*., 2001), quality standards for which were determined by a government-commissioned Expert Panel on Air Quality Standards (EPAQS). The Air Quality Regulations 1997 (http://www.legislation.gov.uk/uksi/1997/3043/regulation/1/made) provided the legal framework. Amendments and updates are made to the Strategy from 'time to time'. A second edition of the Strategy was published in 2000, which brought into effect the new Air Quality Objectives for the eight specified pollutants. An additional revision was published in 2007 (Defra, Scottish Government, WAG and DoE/NI, 2007) and updated technical and policy guidance was published in 2009 (Defra, 2009a; Defra, 2009b). A further revision of the Policy and Technical Guidance was published in 2016 (Defra 2016a, Defra 2016b), with separate Technical and Policy guidance published for Wales, Scotland and London recognising their devolved status for the purpose of LAQM (Defra, undated). Implementation requires action at the national level, central government and its agencies establishing protocols and standards. However, the principal action takes place at the Local Authority (municipality) level, with the authority required to undertake periodic reviews and assessments of air quality. Where the Local Authority identifies an exceedance of one or more of the prescribed set of local air pollutants, and they have satisfied themselves that relevant public exposure exists for the specified averaging time of the exceeding pollutant, they must declare an Air Quality Management Area (AQMA) and develop an Action Plan to remediate the area of poor air quality (Longhurst *et al*., 2006 and 2009).

It is notable that the LAQM process takes a narrow effects-based approach focusing on specific gases and fine particulates of concern for human health, and also to exceedences of objective concentrations at a highly localised scale (see for example Longhurst *et al*., 2009). Other impacts such as emissions of climate-active gases are not addressed within the LAQM framework, although 'air quality' pollutants at local scale derive from similar sources to those of carbon and other climate-active emissions (Ravishankara *et al*., 2012). Emissions affecting outcomes for climate change and public health related to poor local air quality are so interlinked that air quality needs to be co-managed with climate mitigation and adaptation strategies (Ravishankara *et al*., 2012), with linked co-benefits providing a strong rationale for their co-management (West *et al*., 2013).

In theory, such co-management strategies could be integrated into aspects of the LAQM process to facilitate local authority-driven co-benefit reductions in carbon emissions. However, in practice, measures to address climate change and health-related air pollutants are not integrated, but are managed under different strands of legislation, government guidance and non-statutory agreements in the UK, and often also enacted at different management tiers in local authorities (Baldwin *et al*., 2008). Nevertheless, the LAQM process requires many methods, skills and collaborative networks that could also be exploited to put in place an effective carbon management framework at the local

level. Failure to integrate these requirements represents a missed opportunity in legislation and policy, as measures put in place potentially generate a wide range of both 'win-win' opportunities (such as emissions reductions addressing both health-related and climate impacts simultaneously) and 'win-lose' trade-offs (such as traffic diversion to reduce local pollution of health-related gases which may increase net emissions of these substances as well as climate-active emissions which have impacts at global as well as local scales). From a whole-systems perspective, environmental policies for air quality management and climate change should no longer be treated in isolation due to their potentially synergistic or antagonistic relationships (Baldwin *et al*., 2009; West *et al*., 2013).

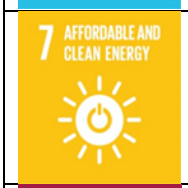
Beyond these climate-related concerns, all other ecosystem services identified by Thornes *et al*. (2010), Everard *et al*. (2013) and Everard (2015) are currently omitted from consideration in terms of the measures put in place to manage local air quality. However, redistribution of pollutants from local concentrations may have impacts on many of these services. Some of these potential but often poorly understood impacts include the effects of pollutants such as ozone on agricultural productivity, nitrogen as a source of eutrophication and habitat change (Sarkar and Agrawal, 2010), impacts of diverted traffic or activities and emissions on aesthetic quality, property values (Bateman et al., 2001) and potential tourism as well as the quality of air used for industrial purposes. What is most striking is that a fragmented policy environment means that, in considering actions to manage air quality, local authorities are guided to consider a wide range of issues including those with potential antagonistic outcomes for climate change gas emissions. However, the primary considerations will be the impact of measures on public health, the economic cost and the overall acceptability of the measures proposed. Given the market pressures to cut costs through ignoring or not tackling 'externalities' to the market and legislation, wider negative consequences are highly likely.

By comparison, an ecosystem approach requires consideration of the full suite of ecosystem services, addressing whole socio-ecological systems and their many stakeholders at different spatial and temporal scales likely to benefit or suffer from management changes (Millennium Ecosystem Assessment, 2005). This is not only a more inclusive approach that recognises transparently the likelihood of adverse impacts, and identifies stakeholders who should be consulted or at least considered, but also provides a basis for innovation to deliver multiple benefits across policy areas. Practical examples of measures that may achieve this whilst addressing LAQM priorities include walking routes and affordable public transport systems, or the promotion of mixed development with employment and retail close to habitation. Such measures may reduce the need for journeys and associated emissions, albeit that this relates to synergies between policy areas not traditionally considering air quality implications. There are clear potential economic benefits from such integrated policies, providing multiple and diverse 'wins' across policy areas. This has been recognised in the UK's 'Stern Review' of the Economics of Climate Change (Stern, 2006), which states that *"Policies to meet air pollution and climate change goals are not always comparable. But if government wishes to meet both objectives together, there can be considerable cost savings compared to pursuing them separately*". The same principle applies across all policy areas and the ecosystem services associated with them, including those services currently not central to decision-making but which may nevertheless be impacted along with their beneficiaries.

The failure of the LAQM framework to address air quality other than in terms of exceedences of specific pollutants in defined locations, delimited by narrowly framed legislation, has thereby overlooked wider-scale impacts, the potential for co-management of different types of polluting gases, and net consequences for a range of human needs. As with regulations and tools governing the European chemicals industry, limited focus results in enforcement actions that are only poorly connected with human needs and sustainable development. It is insightful to examine the contribution that the LAQM process and outcomes has in relation to the 17 SDGs. Table 4 presents a high-level analysis of the contributions that LAQM makes to the seventeen SDGs. From this, it is clear that the contribution of LAQM in practice or potential is focused principally on just four SDGs: 3

(health), 10 (reduced inequalities), 11 (sustainable cities) and 17 (collaboration to achieve goals), with some coincidental, modest contributions to eight other goals.

Table 4: Contribution of LAQM to the seventeen UN SDGs

Sustainable Development Goal	LAQM Contribution
	• No direct impact from LAQM
	• No direct impact from LAQM
	• Direct contribution, albeit addressing localised impacts through Action Plans designed to reduce public exposure to air pollution. Further indirect contributions may arise through raising public awareness of the risks associated with air pollution exposure
	• No direct impact from LAQM
	• No direct impact from LAQM
	• Minor indirect benefit from reduced pollutant deposition to watercourses, though highly localised and failing to address catchment-scale deposition issues
	• Modest indirect impact via stimulation of market for cleaner energy sources
	• Modest indirect impact via stimulation of market for greener technologies
	• Modest indirect impact via stimulation of market for greener technologies

	• Limited indirect contributions through the impacts of Action Plans on remediating air pollution inequalities, as the outcomes of LAQM highlight inequalities in exposure to elevated concentrations of air pollutants including the skewing of worst conditions borne by the poorest in society (Gegisian *et al*., 2006)
	• Direct contributions are achieved through integration of air quality considerations into Land Use planning processes, though only in generally urban areas of excessive pollution
	• Indirect impact via stimulation of market for greener technologies, such as low-emission vehicles (Defra, 2009c)
	• Modest indirect contribution where co-beneficial opportunities have been realised and corrective actions implemented, but impact is mainly indirect due to a lack of general integration in planning for climate change and health-related air pollutant emissions (Baldwin *et al*., 2008)
	• Minor indirect contribution from reduced pollutant deposition to watercourses, given the generally urban 'pollution hotspot' nature of LAQM
	• Minor indirect contribution from reduced pollutant deposition to terrestrial ecosystems, noting that AQMAs are generally urban and therefore not necessarily close to rural impact areas
	• Supporting contribution as LAQMs seek to remove adverse air quality 'hotspots'
	• Direct impact through stimulation of joint working across central and local government silos, and between national and local state agencies, enterprises and NGOs (e.g. Beattie and Longhurst, 2000; Beattie *et al*., 2004; Olowoporoku *et al*., 2011)

In concluding this review of operation of LAQM in the UK, it is important to highlight that the potential contribution of LAQM to the suite of SDGs has recently been highlighted by a new version of LAQM Policy Guidance released by the Welsh Government (2017). Instead of a narrowly defined prescription of the duties of local authorities, this new guidance sets out a broad-ranging approach inviting joined-up working to achieve multiple outcomes, and warning against short-term solutions to non-compliance with air quality objectives. By including the Wellbeing Act 2015 (Welsh Government, 2015) within the Policy Guidance, the Welsh Government is seeking a much broader consideration of the impact of air quality management and, in so doing, moves the LAQM process in Wales firmly in the direction of contributing to multiple SDGs. This position in Wales is now substantially different from that of the other constituent parts of the United Kingdom, though its practical application has yet to be seen. It is uncertain at this stage whether England, Scotland and Northern Ireland will follow the Welsh lead.

Everard, M. and Longhurst, J.W.S. (in press). Reasserting the primacy of human needs to reclaim the 'lost half' of sustainable development. *Science of the Total Environment*, STOTEN-D-17-07197R1.

Discussion

The three case studies represent a spectrum of responses to complex and challenging environmental issues in terms of their contribution to the seventeen UN Sustainable Development Goals, assessed against the Brundtland principles of: fulfilling human needs now; recognising that means by which needs are addressed can limit or open future opportunity; and commitment to intergenerational equity.

Transposition of the higher-level intent of sustainable development into statutory instruments governing chemical safety and air quality exemplify a paradigm of localised, hazard-based reaction that overlooks wider spatial and life cycle implications for meeting human needs. By contrast, the PVC case study identifies how voluntary commitments connected along a value chain can elevate action from incremental measures to meet constraining regulatory standards towards innovation to profitably address societal needs in an increasingly sustainable way. Similarly, the case study on river quality management in England highlights regulatory evolution through co-learning across a range of formal and informal partnerships with non-government actors, shifting the focus of river quality management closer to meeting locally identified needs spanning multiple policy areas. A significant contributor to success has been linking up across societal sectors, formally in the case of river quality management in the UK and informally in the case of PVC in the EU. LAQM to date has remained rooted in the meeting of national objectives at the local level, rather than linking across topics to co-manage climate-active gas emissions, and recognising and expanding to address broader human needs, though the novel approach recently signalled in Wales elevates intent to include a more 'joined-up' approach explicitly considering multiple dimensions of human wellbeing. The contributions that the three approaches make to addressing human needs is summarised in Table 5. The disjoined approach of LAQM is revealed by the high number (4/17) of nil contributions to SDGs, as compared to river quality management (3/17) and PVC water pipes (0/17); LAQM also makes fewest direct contributions to SDGs (3/17) as against river quality management (8/17) and PVC water pipes (7/17). As the PVC water pipe and river quality management case studies cross societal sectors seeing co-benefits, it is unsurprising that they generate significant indirect potential contributions to the SDGs (8/17 and 5/17 respectively), although despite the narrow application and missed opportunities for co-management in the LAQM case study it nevertheless generates a significant number albeit of moderate potential indirect contributions (9/17) despite its low direct contributions to the SDGs. Whilst the regulatory compliance model mostly explains this pattern, it may also be a function of the local scale at which LAQM operates unlike the other two case studies. It is the intention of Welsh Government that its recent, though at present not implemented, regulatory revision should increase the direct and indirect contributions of LAQM to meeting the SDGs.

Table 5: Summary table direct (green), indirect (amber), supporting (yellow) or no (red) contribution of case studies to meeting the SDGs

Sustainable Development Goal	Potential contributions of PVC water pipes	Potential contributions of river quality management	Potential contributions of Local Air Quality Management
1. 	Indirect	None	None
2. 	Indirect	None	None

3. 	Direct	Direct	Direct
4. 	Indirect	Direct	None
5. 	Direct	None	None
6. 	Direct	Direct	Indirect
7. 	Indirect	Indirect	Indirect
8. 	Direct	Indirect	Indirect
9. 	Direct	Indirect	Indirect
10. 	Supporting	Direct	Indirect
11. 	Direct	Direct	Direct
12. 	Direct	Indirect	Indirect
13. 	Indirect	Direct	Indirect
14. 	Indirect	Indirect	Indirect
15. 	Indirect	Direct	Indirect
16. 	Supporting	Supporting	Supporting
17. 	Indirect	Direct	Direct

Another pattern that emerges here is that these outcomes are highly context-specific, responding to geography and level of development. The potential contribution of water pipes was framed in a developing world context where the need for water efficiency and its linked benefits for food, gender empowerment, food production and other services was maximised. Equally, the benefits of river quality management were considered in an English context, where there is a well-established network of civil society organisations. Outcomes might be rather different if the contribution of PVC pipes were to be assessed in an industrialised context, or river quality management considered in a developing world situation where civil society participation was weak or suppressed. The enabling socio-political environment then exerts a *force majeure* on potential progress with the SDGs.

A narrow regulatory focus on management of pollution and other negatives on its own tends to be perceived as a constraint, limiting aspirations and potential innovation and investment to maximise the meeting of human needs. Much of legacy regulation posits businesses and other enterprises as potential environmental hazards, often failing to recognise their positive roles in producing 'satisfiers' for advancing human wellbeing. Consequently, managerial interpretations of environmental issues and corporate choice of environmental strategy are shaped by conformance to regulations and standard industry practices with a smaller proportion undertaking voluntary actions which may be perceived as either threats or opportunities or discretionary factors rather than fundamental to business (Sharma, 2000). Perception of business as a source of environmental risk, though partially true, omits that higher purpose of sustainable development, largely omitted by legacy regulation but clarified by the SDGs.

This narrow regulatory perception of business as hazard rather than enabler is at odds with its origins. The origins of the contemporary and now substantially globally pervasive business model lie in the European Industrial Revolution, as a means accepted by society for converting raw resources into useful products to meet human needs. Industrialisation has and remains a significant force propelling human progress albeit, with the benefits of hindsight, also inadvertently precipitating a diversity of today's sustainability challenges. Furthermore, the unprecedented personal wealth generated in the early phases of industrialisation engendered a golden age of philanthropy, when captains of industry reinvested in public 'goods' such as libraries, civic parks, hospitals, schools and museums recognising a duty to promote these different spheres of public need. Business subsequently lost its way, with competitive profit-taking often framed as a sole goal at any wider cost by the 1980s under a 'monetarism' philosophy where social and environmental implications are subservient to pursuit of financial return (Congdon, 2007). Since that nadir, a journey back to primary purpose reconnecting business with societal concerns can be discerned in emerging recognition of the need for a 'triple bottom line' sustainable pathway of development (e.g. Elkington, 1997), Corporate Social Responsibility and other initiatives. Leading enterprises grasped social and environmental responsibilities as a differentiator, defensively averting bad press and supply chain instability, but also positively promoting preferred supplier status and motivating and giving confidence to staff and investors. Furthermore, in today's internet age, disclosure of bad practice is only two clicks away. What the SDGs bring to this repurposing of business and reframing of regulation is explicit recognition of the spectrum of needs that corporate and public policy sector exists to serve; the 'missing half' of the sustainable development narrative. Business sectors have to continue addressing the challenges of becoming 'less bad' for the environment and human health, but can also engage proactively and meaningfully with their role and primary purpose of meeting consensual human needs with appropriate 'satisfiers' on a sustainable basis. This is perhaps most dramatically illustrated by the transition of the EU PVC industry from near-pariah status in the 1980s towards current recognition by the UN and EU of its voluntary commitments as exemplars of progress towards the circular economy and international cooperation around the SDGs. Addressing SDG12, 'Responsible consumption and production', Kobayashi and Fukushige (2017) address environmental burden from both a product life cycle and consumer quality of life perspectives, explicitly linking human needs and their satisfiers with the product development process. Reconnecting business management and regulation with positive contributions to meeting human needs is essential if they are not to act as inhibitors to progress with innovation for sustainable development. This then 'repurposes' business and other institutions on new, sustainable and profitable opportunities arising from addressing needs in the most resource efficient, clean and socially responsible and uplifting manner.

What the SDGs enable is elevation of the vision and perception of sustainable development from one of compliance with minimal acceptable standards towards potential contribution to meeting consensual human needs. This transition returns understanding of sustainable development closer to the spirit and framework outlined by the Brundtland Commission, itself embedding a trajectory of

conceptual development dating back to the World Conservation Strategy and its predecessor initiatives. For society, including those businesses repurposing themselves around this higher vision, it reframes all sectors as playing a range of potential roles in the advancement of human development; a far more motivating vision than a daily struggle to maintain profits by being 'less bad' as reflected in legacy regulatory requirements.

A significant challenge remains to develop a new regulatory model to embody the visionary aspects of sustainable development in addition to minimal performance. This transition in governance and management is required if the aspirational spirit of sustainable development is to be realised, driving progress with interdisciplinary research and complexity-based governance that is partnership-based rather than proscriptively top-down (Loorbach, 2010). Evidence from these three case studies suggests that a more participatory approach is required, informed by engaging affected sectors in benefit realisation. The substantially devolved partnership model of river quality management has parallels with the twin track of the PVC sector comprising both regulatory enforcement and voluntarily engaged and audited progress. The air quality case study indicates that a different framework for considering the integrated consequences for the atmosphere, human health and societal wellbeing could reconnect regulatory compliance concerns with the broader social purposes at the heart of the meaning of sustainable development. In this regard, recent inclusion of aspirations to meet human needs and invitation of joined-up working to achieve multiple outcomes, as opposed to establishing narrow and localised minimal standards, marks a progression along the lines of the WFD's focus on Good Ecological Quality rather than control of narrowly defined environmental pressures.

In conclusion, the three case studies viewed through the lens of the SDGs provide evidence that, in very different contexts and scales of engagement, significant progress and/or further opportunity is evident, with the capability to reclaim and reconnect the visionary 'lost half' of sustainable development.

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