Self Organization under Deliberate Direction:

Irish Dairy and the Possibilities of a New Climate Change Regime

Charles Sabel,* Rory O'Donnell** and Larry O'Connell***

*Columbia Law School

**Director, National Economic and Social Council, Ireland

***Senior Economist, National Economic and Social Council, Ireland

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Abbreviations

ACP	Agricultural Catchments Programme
ASSAP	Agricultural Sustainability Support and Advisory Programme
CAP	Common Agricultural Policy
CSMU	Catchment Science and Management Unit
CSO	Central Statistics Office
DAFM	Department of Agriculture, Food and Marine
DII	Dairy Industry Ireland
FDI	Foreign direct investment
DHPLG	Department of Housing, Planning and Local Government
DSI	Dairy Sustainability Ireland
EPA	Environmental Protection Agency
ETS	Emissions Trading System
GAP	Good Agricultural Practice
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GLAS	Green Low-Carbon Agri-Environment Scheme
GMO	Genetically Modified Organism
IEE	Irish Economic Expenditures
IFI	Inland Fisheries Ireland
INAB	Irish National Accreditation Board
ISO	International Organization for Standardization
LAWPRO	Local Authority Water and Communities Programme
MACC	Marginal Abatement Cost Curve
NAP	Nitrates Action Programme
RBMP	River Basin Management Plan
SDAS	Sustainable Dairy Assurance Scheme
TAC	Technical Advisory Committee
UNFCCC	United Nations Framework Convention on Climate Change
WFD	Water Framework Directive

1. Introduction

In this essay we use the example of the Irish dairy industry to show how, even in the absence of any overarching design, mutually reinforcing developments in methods of regulation and production can generate expansive regimes that encourage efficient production of higher quality and safer goods while improving protection of the environment. At the root of these changes in production and regulation are constant, unforeseeable shifts in markets and technology that expose the limits of reliance on fixed, general regulatory rules and operating routines, and the corresponding need to adjust even the most precise precepts to the changeable context in which they are applied. Regulators and firms respond to this uncertainty by assigning more responsibility to front-line or ground-level actors to closely and continuously monitor all stages of operations, using disruptions to signal the limits of plans and precautions and prompt search for underlying faults or deficiencies in product design, the set-up of production or in the governing rules and regulations themselves. These responses are mutually reinforcing: the monitoring practices adopted for commercial reasons by the most ambitious and capable firms inform the official requirements that regulators impose on the others, and the standards that regulators, acting on their political mandate, impose or (more often) threaten to impose on private actors leads the most proficient among them to intensify their self-scrutiny and correction, if only to put pressure on the rest. Where ongoing revision of regulation buttresses continuing changes in production, and vice versa, in an iterative cycle, collaboration between public and private actors and among various public agencies becomes regular and formal. The absence of a grand design notwithstanding, the result is an increasingly effective and extensive regulatory regime in which new forms of ground-level cooperation among public actors from various departments, private stakeholders and civil-society organizations are indispensable to keeping rules current and making them workable.

In recursive regimes of this type general rules are regularly corrected in application and the corrections incorporated into new rules. Such regimes could eventually be a model for, and building blocks of, a post-Paris mode of climate change governance that would not be top-down without being, in the conventional sense, bottom-up.

Irish agriculture, dairying in particular, is one of the domains in which this type of collaborative regime building, focused on ensuring the quality and safety of products and protection of the environment, has gone farthest and where therefore the co-evolution of public and private organizations, along with its preconditions and possible implications, are most easily observed. Irish dairying is grass-based, and in

the hands of small, family farmers, who typically pasture from 45 to 68 cows on 75 to 250 acres (CSO, 2010: 61). Dairy farmers are as a rule member-owners of one of six large and sophisticated dairy cooperatives, which process and market the milk they supply as various products, many of them, especially food ingredients, highly innovative. The costs of milk production at the farm are amongst the lowest in the world, and the industry as a whole is globally competitive. Almost 90 per cent of domestic production is exported, primarily to other member states of the EU, Asia and the US. The most successful dairy coops, such as Glanbia and Kerry, are rapidly expanding abroad, primarily in the US. Irish milk production at the farm is the most carbon efficient—the least burdensome to the climate—in the EU, and on many accounts the world, as measured by the pounds of carbon released into the atmosphere per pound of milk solids produced (Leip *et al.*, 2010). Ireland is pioneering new governance arrangements for the control of polluting runoff from agriculture under the EU's Water Framework Directive (WFD).

These achievements are the joint product of four principal actors, initially working at some remove from each other, now increasingly engaged in close, often institutionalized collaborations that, taken together, constitute a comprehensive regulatory regime for Irish dairying, and agriculture in general, in all but name. In the private sector the key actors are the dairy cooperatives and their member farmers. In the public sector the key actors are three: Bord Bia, a state agency originally directed to market Irish food products abroad but in recent years dedicated to creating and maintaining the Origin Green standard, the first of its kind in the world, under which both farmers and food processors can be certified as meeting the requirements of "sustainable" production; the Irish Environmental Protection Agency (EPA), responsible, like its US namesake, for establishing a process for translating general legal provisions protecting the environment into precise and practicable requirements, and overseeing their enforcement; and Teagasc, the state agency within the Department of Agriculture, Food and the Marine (DAFM) that provides policy-oriented and technical research, largely to the government and farmers' and processors' organizations, and extension services to farmers.

In each of these domains—production, standard setting, environmental regulation and policy formation linked to extension—the respective actor, in large measure independently of the others, has come to see that rules or services must be contextualized to be effective. In all four there is movement from top-down prescription to the conviction that the most current analysis and the precepts that embody it are best used to focus investigation at ground level of how the general ideas are to be applied and, if need be, the analytic understanding and associated rules revised. Put another way, high-level instructions come to be seen less as fixed

rules and more as rebuttable presumptions, subject to correction by local analysis and experience. It is emblematic of this shift that high-level policy frameworks are sometimes themselves explicitly designed as instruments for evaluation of local contexts; and even when this is not their declared purpose, general instructions are more and more frequently accompanied by tools to guide local use. The fullest expression of this changed understanding is the creation of new governance structures to institutionalize full local participation in the application of rules, and eventual reconsideration of national policies.

Origin Green, for example, was first conceived as a system of audits to verify that farms and food processing firms comply with minimum requirements; by the time it was launched it had become a platform, combing audit results with data from many other sources, to suggest concrete possibilities for improvement to each farmer. The EPA, struggling for decades to come to grips with diffuse or non-point water pollution, especially from farms, has focused more and more on catchment-level analysis, and the need, as a condition of pollution reduction, to identify not just the source of a stream of pollutants and but the precise path it follows to its destination. In their own processing operations, dairy cooperatives are adopting advanced manufacturing techniques that use small deviations from target outcomes to direct attention to latent problems in the organization of production. They are cooperating with Teagasc to develop machine learning tools to help their member suppliers adopt analogous techniques to the management of grass growing, paddock by paddock, and the movement of the herd through the pasture to ensure efficient use of the nutrients; the cooperatives are also expanding, again often in collaboration with Teagasc, the technical support they offer member suppliers to meet ever increasing quality and environmental standards, and to improve the efficiency of production. In its policy recommendations Teagasc has, as part of an EU network of peer researchers, shifted from recommending national policies, ranked in order of their cost effectiveness, to advocating regional and local differentiation of policy to take account of variations in soil types and micro climates. In the same vein Teagasc explicitly presents this analysis as an aid to local deliberation about policy choices, not a substitute for it. The EPA, Teagasc and local authorities have established new governance arrangements to couple improved detection of pollution problems with the provision of technical support in addressing them in ways that reconcile, to the extent possible, local public needs and the interests of immediately affected actors; and these local innovations are complemented by the creation of a national Water Forum, including a wide range of stakeholders, to help set national priorities for water provision and pollution control.

Particularities of the Irish setting have favored this outcome, accelerating learning by each actor and consolidation of their efforts, in the process enhancing the status of environmentally-oriented actors while muting earlier agricultural resistance to regulation, and making it still easier to find ways of reconciling environmental sustainability and productive efficiency. Ireland has almost no heavy industry. Dairy farming is the most dynamic part of agriculture; ruminant livestock are potent emitters of greenhouse gases, and the excess application of fertilizer in the cultivation of pasture grass results in polluting runoff. These circumstances have put agriculture in the crosshairs of Irish environmental policy and debate: Ireland's efforts to meet its national quota for green-house gas (GHG) emissions reduction under an EU agreement and to comply with the EU's WFD have exerted increasing pressure on agriculture, dairy farmers first and foremost, to reduce emissions and nutrient run-off. Though the penalties for non-compliance are vague, they could be draconian. The prospect of such a penalty default—an outcome incomparably worse than any the actors could have devised cooperatively, and imposed only if they obstinately refuse to work together—has in combination with the visibility of the sector made inaction or sham reform unacceptably risky.

In Ireland the politics of environmental protection and climate change policy has been shaped largely by shifts in the interests and strategies of actors within small-holder agriculture itself. Until recently Irish beef and dairy farmers were tolerably content with the EU's subsidy and dairy production quota system. Their organizations, in concert with the DAFM, defended that regime: Teagasc's policy reviews, for example, emphasized the costs of new environmental requirements and the need for delayed compliance. A primary task of the extension service was (and often still is) helping farmers complete annual applications for subsidies. The growing realization by the coops and their expansive members of the economic potential of high-quality dairy products sustainably produced upended this concertation. The coops' goal is now to make sustained environmental improvement affordable, not simply minimize adjustment costs; this requires new partners, such as the EPA, with deep expertise in the science and practice of abatement, and new forms of cooperation with the extension service, focused on capacity building, not compliance with formalities. The traditional farmers' organizations are seeking to define their place in the new institutions of public-private governance that are re-wiring the circuits of politics within the sector—a transformation the established lobbies can shape, but not block. Without allies to defend an increasingly questionable *status*

quo, serious and sustained efforts to address environmental issues proves a last resort and a prudent strategy for them too.[1]

Against this backdrop all those particularities of climate and soil that make Ireland the Emerald Isle came to be understood as an invaluable resource. Through the first decade of this century Irish grass-based, small-holder dairy farming was seen as an historical legacy of complex struggles over agrarian property and, relatedly, a tardy shift to cooperative processing,[2] not the foundation for a highly competitive and sustainable model of production. In the late 19th century Irish butter producers lost out to Danes in the competition to supply the British market, largely because the Danes adopted more enclosed, industrial methods before the Irish could. For much of the last century family dairy farms were seen as an economic pillar of rural society, itself deeply entwined with Irish identity, but hardly at the vanguard of advanced production and environmental protection.

As the pressures for environmental improvement combined with growing consumer demand for healthy, natural foods produced under sustainable conditions, there has been a thoroughgoing re-evaluation of the potential of the grass-based model. Compared to concentrates, pasture grass is a low-cost nutrient. Its price is little effected by fluctuations in other markets; cows that graze on pastures produce milk solids of superior quality; and the grazing cow is the emblem of food production at its most natural. But bettering the returns to farming by increasing the quality and yield per acre of grass requires constant attention to the condition of soil and water, and the choice and application of seeds, fertilizers and other inputs. Ensuring that the dairy cows have the fullest possible nutritional benefit of the available grass requires constant attention to the state of each paddock, the daily grazing routine of the herd and the calving cycle. Thus, just as the creation of a coalition focused on agricultural sustainability cleared the way for an arduous and continuing spell of policy learning, so the natural endowment of grass was an enabling factor, not in itself a naturally occurring solution. Grass became an invaluable asset, and an important means of reconciling sustainability and efficiency, only when its production was made subject to the same close and continuous monitoring—and

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[1] The increasing environmental emphasis in current reforms of the EU's agricultural subsidies (European Commission, 2017) may well be reinforcing the farmers' organizations belief that sustainability is central to their members' future prosperity.

[2] For the rich debate on these developments see Henriksen, Ingrid, and Kevin H. O'Rourke "Incentives, technology and the shift to year-round dairying in late nineteenth-century Denmark." *The Economic History Review* 58.3 (2005): 520-554; O'Rourke, Kevin H. "Culture, conflict and cooperation: Irish dairying before the Great War." *The Economic Journal* 117.523 (2007): 1357-1379; and Henriksen, Ingrid, Morten Hviid, and Paul Sharp. "Law and peace: contracts and the success of the Danish dairy cooperatives." *The Journal of Economic History* 72.1 (2012): 197-224.

correction of routines—characteristic of advanced production throughout the economy.[3]

Ireland is distinctive in the weight and balance of features favouring the relatively speedy and harmonious emergence of a recursive regulatory regime, but it is not singular. The deep changes that foster the co-evolution of production and regulation are by their nature general; they are most conspicuous in the organization and regulation of firms participating in international supply chains that produce goods as varied as pharmaceuticals, food stuffs, automobiles and forestry products. All advanced countries by definition participate amply in these supply chains; all have substantial archipelagos and peninsulas of activity where close monitoring and quick correction of production and regulation is routine. And, in loose connection to the expansion of these practices, the political constellations allowing the formation of recursive regulatory regimes are becoming more favorable, with great variation from country to country and, again, with few countries where the conditions are as favorable as Ireland's. Notoriously polluting industries are as a rule now subject to a combination of national and international sanctions—imposed by domestic legislation, trade restrictions, the contracts of leading multinational firms with their suppliers, or vigilant civil society actors mobilizing public indignation—that expose polluters to the same imprecise but credible threat of possibility draconian sanctions that helped make problem-solving the dominant response to environmental constraints in Irish agriculture.[4] As clean technologies become more efficient, and demonstrate the potential for dramatic further improvement, continued investment in dirty, legacy installations becomes economically irrational—the folly of throwing good money after bad;[5] it becomes harder to build the kinds of coalitions resisting stronger environmental regulation. Nothing in these considerations warrants the claim that there is at present a deep logic of change that culminates in the recursive

[3] The abundance of "natural" resources results as much from the technical ability of a national economy to discover and extract them as from the endowments of nature. See Ville, Simon, and Olav Wicken. "The dynamics of resource-based economic development: evidence from Australia and Norway." *Industrial and Corporate Change* 22.5 (2012): 1341-1371.

[4] Take, as one example for many, the thicket of regulation now surrounding the growing and processing of palm oil. Unconstrained expansion of cultivation often results in deforestation. Pacheco, Pablo, *et al.,* "Governing sustainable palm oil supply: Disconnects, complementarities, and antagonisms between state regulations and private standards." *Regulation & Governance* (2018).

[5] GE's failed merger with the French producer of power generating equipment Alstom is instructive. GE expected that Alston's large installed base of equipment would reliably generate service revenue for the foreseeable future. The sharply declining costs of wind and solar power have so impaired the value of the existing fleet of coal-and gas-fueled plants worldwide that GE has written off essentially the entire value of the acquisition. (Crooks, 2018, Industrial Stalwart GE Contemplates an Overhaul, *Financial Times*, October 5).

regime-building seen in Ireland. But these same considerations do make it plausible to see Irish developments not as an accidental visitation from an impossibly remote, alternative reality, but as a possible and promising outcome in many places, and perhaps generally, of the current conflicts over production and regulation.

This essay presents the co-evolution of production and regulation in Irish dairy farming in that light. The next part presents the Irish context in the relevant detail. The following parts trace the actions of, respectively, Bord Bia, the EPA, the dairy cooperatives and farm organizations and Teagasc, and the growing collaboration among them. In the conclusion we suggest why the kind of experimentalist regime exemplified in Irish developments is a promising alternative to the Hobson's choice between top-down and bottom-up regimes that clouds current debate about the governance of climate change mitigation.

2. The Irish Context

Dairy as the Engine of a Sustainable Agri-food Sector in Ireland

Foreign direct investment (FDI) in high-technology sectors such as information technology and pharmaceuticals underpinned Ireland's Celtic Tiger boom from the mid-1990s to the Great Recession in 2008. The severity of the ensuing crisis and the need for an export-led recovery focused attention on the continuing importance of the agri-food sector—including farm products such as beef and milk as well as processed products such as infant formula, food ingredients and beverages—and above all on the export potential of dairy.

The agri-food sector is Ireland's most significant indigenous sector. It accounted for almost 10 per cent of export earnings in 2008, but when beverages, infant milk formula and food ingredients are included the percentage rises to 19 (Riordan, 2012). In 2017, the share of agri-food exports had risen to 11 per cent of export earnings (DAFM 2018:1)[6]. These figures understate the sector's actual contribution to the national economy. The share of imports is much lower in the inputs of agri-food firms than in the inputs of transnationals in pharmaceuticals and information technology; and the profits earned in the domestically owned agri-food firms remain in Ireland, while the earnings of the high tech firms are repatriated to their foreign owners. Consequently, per unit of output and exports the agri-food sector makes a

[6] Annual Review and Outlook for Agriculture, Food and the Marine 2018 (DAFM, 2018:1)

larger contribution than the sectors dominated by FDI to the balance of payments and employment, as well to regional and rural development.[7]

Within Irish agri-food and bio-economy, dairy is the sector which has much the greatest potential. Through much of the 20th century Irish dairy farming, like Irish farming generally, was dominated by extremely small holdings, with limited export opportunities and relatively low productivity and incomes. Membership in the European Economic Community (the predecessor of the EU) and its Common Agricultural Policy (CAP) in 1973 increased market access and prices, prompting increased commodity milk output, productivity and incomes. But the imposition of EU milk quotas in 1984 set absolute limits on milk production and prompted consolidation in the sector. The number of dairy farms fell and herd sizes increased, yielding a smaller but more efficient and capable cohort of specialized dairy farms still small in comparison to industrial producers: In 1984 there were 80,000 active milk producers, by 2014 this had fallen to 18,000 (Donnellan *et al*., 2015); and average herd size increased in this period from approximately 20 cows in 1984 to 80 in 2017 (CSO, 2018). The Irish coops also consolidated[8] and became first-tier suppliers of ingredients to leading global consumer food firms, such as Abbott Nutrition, Danone, Nestlé's Wyeth Nutrition and Mondelēz, which built processing plants in Ireland. In this way Ireland—which accounts for only around 4 per cent of EU milk and less than 1 per cent of global milk output (Eurostat 2017 and FAO, 2018:5)—supplies, in 2017, almost 15 per cent of the world's infant formula market and is the second biggest exporter of infant formula to China[9]—a market acutely sensitive to quality because consumers have reason to fear inferior or even deliberately adulterated products. Altogether, Ireland exports 90 per cent of its dairy output.[10]

The removal of EU milk quotas in 2015—in the context international efforts to reduce market distortions in agriculture—reopened the possibility of expansion based on the relative competitiveness and strategic choice of various EU member states. Recent studies pinpoint grass as the source of the evident competitiveness of Irish dairy. The larger representative Irish dairy farm has the lowest cash cost to

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7 It is estimated that in 2008 the wider agri-food (which includes beverages, infant formula and food ingredients) accounted for 40 per cent of the total net foreign earnings of all primary and manufacturing industries (Riordan, 2012).

8 The consolidation of Irish milk processing is less pronounced than in Ireland's major dairy export competitors, such as Denmark, the Netherlands and New Zealand, where one company processes as much as 70 or 80 per cent of the milk pool (Prospectus, 2003).

9 https://www.bordbia.ie/industry/manufacturers/insight/alerts/pages/chinadairyimports.aspx

10 http://www.bordbiavantage.ie/market-information/sector-overviews/dairy/

output ratio of the key international milk producing regions, including the US, New Zealand and Australia (Thorne *et al.,* 2017: 70) and research has shown that expansion of Irish dairy should focus on increasing grass growth and grass utilization at farm level (Shalloo *et al.,* 2011 in Hanrahan *et al.,* 2017). Home-grown, grass feed is much cheaper than purchased-feed concentrates; and its price is relatively stable, while the price of purchased feed fluctuates with the price of the fuel used to produce it. Reduction in the price volatility of a key input in turn shelters Irish dairy farmers against a substantial risk. With the expansion of production and slight increase in the size of herds that followed the phase-out of the EU milk quotas the costs of dairy production declined more in Ireland than in other member states, suggesting that the home-grown feed model will fare well in international competition (Thorne *et al.,* 2017: 70). Confident in this prospect the Irish coops, while remaining first-tier suppliers in the quality commodity and ingredients markets, are aiming for greater autonomy from their large customers by further upgrading their quality standards and developing and marketing differentiated products directly to retailers and consumers.

Together these factors make dairy much the most profitable, innovative and promising branch of Irish agriculture. Just as increases in agri-food production have greater spillover effects than increases in other sector, so increases in dairy production generate greater spillovers than increases in the rest of agriculture-food (Miller *et al.,* 2014: 156). Moreover the co-operative model in dairy has facilitated relatively orderly coordination of the value chain, particularly of relations between family farms producing milk and the large processors which they both supply and partially own. By contrast, the Irish beef value chain is characterized by recurrent conflict between farm producers and processing firms (Heery, 2015). Consequently, the expansion of sustainable dairy production and value-added products dominates plans and projections for the future of Ireland's agriculture and food industry.[11]

Since the turn of this century, the Irish dairy sector—farmers, farmer organizations, producer coops and their industry associations—have come to see the national system of grass-based dairying on family farms as a model of production that can reconcile increasing efficiency with environmental sustainability, and is all the more appealing to consumers precisely because of its ability to do so. This is evident in the increasing prominence of sustainability concerns in a series of sectoral plans, agreed

[11] The Food Harvest 2020 strategy of 2010 set a target by 2020 of a 50 per cent increase in the volume of milk production over the average of 2007-2009 milk supply (4.93 billion litres). The volume of milk production in 2017 had reached 7.27 billion litres, an increase of 47 per cent (CSO 2018) - https://www.cso.ie/en/releasesandpublications/er/ms/milkstatisticsdecember2017).

by stakeholders every ten years (and revised every five), starting in 2000. The strategy adopted in 2010, *Food Harvest 2020*, directed the sector to focus "on the opportunity presented by consumers who demand the highest quality in production and environmental standards" (DAFF, 2010: 3) and underlined that "Ireland's extensive, low-input grass-based production systems are the foundation of its green credentials" (*op cit.*:5). This perspective reflected and contributed to the Irish coops' realization that enhancement of their supply chain—through improved soil fertility, stock quality, nutrient management planning and low-carbon production on their members' farms—is key to their success, and the broader reorientation, between 2012 and 2016, of Ireland's agricultural actors from resisting the climate change agenda to identifying mitigation measures and engaging front-line actors in initial trials of them.

The EU Legal Framework

EU law compelled Ireland to respond, haltingly, to the pollution of water and air caused by agriculture long before farmers, farm organizations, dairy coops, the state extension service and DAFM became active advocates of sustainability. The legal obligations were, and in important ways still are, incoherent. Early measures to ensure clean air and water through fixed, national emissions reduction targets reflected the UN integrated and comprehensive top-down approach to climate change; later measures to improve water quality emphasized the need for recursive learning from ground-level implementation, while the EU quota for the reduction of all Irish GHG emissions, and the accounting methods used to judge progress—are still anchored in the framework established by the UNFCCC and the Kyoto Protocol. So, even as Ireland has moved from laggard to leader in implementing the WFD, and Irish dairy becomes a world leader in low-carbon production, expansion of output could lead to legal violations if the current rules and accounting systems for GHGs remain unchanged.

Among the first agriculture and water-related environmental measures enacted by the EU was the Nitrates Directive of 1991 to protect water quality from pollution by agricultural sources. It was highly prescriptive and proved extremely controversial in Ireland (Crowley, 2006; Flynn, 2007, 68-73). The goals of the directive are transcribed in each member states' Nitrates Action Programme (NAP). Ireland's NAP establishes a code of Good Agricultural Practice (GAP): mandatory obligations covering permitted stocking rates, timing of fertilizer application, storage requirements for livestock manures and other parameters (DAF & DEHLG, 2006). DAFM audits farms to assure compliance with these requirements; failure to comply can result in fines and disqualification for the EU single farm payment. The regulation is under constant review. Ireland's NAP was revised in 2010, 2013, 2017 and 2018—a process steered

by an expert group containing not only the agricultural department and Teagasc, but also the department of environment and EPA catchment scientists.

The Water Framework Directive (WFD) of 2000 sets out, in contrast, extremely broad objectives: "good water," including minimal pollution by listed chemicals and "good ecological status," where the latter is defined for each type of water body, such as an alpine stream or freshwater lake, as minimal deviation from the pristine or undisturbed distribution and quantity of phytoplankton, aquatic flora, benthic invertebrates, and fish. An "inter-calibration" procedure assures that countries with say, Mediterranean rivers, including Cyprus, Slovenia and Spain among others, apply comparable standards (Poikane *et al*, 2014). The basic unit of management is the river basin or catchment: the territory that drains, through a sequence of streams, lakes and other water bodies into the sea at a single river mouth, estuary or delta. The Directive requires member states to produce, starting in 2015, a six-year River Basin Management Plan (RBMP) for each basin by a collaborative process in which public officials, experts and stakeholders specify objectives as well as guidelines and procedures for translating them into concrete activities. Until 2027, counties can request additional time for compliance on the grounds that mitigation is currently technically infeasible, disproportionately expensive, or obstructed by extraordinary natural conditions; thereafter, as a penalty default, the Directive no longer recognizes cost and feasibility as excusing non compliance. Each member state appoints a water director, typically the head of the water division in the ministry of the environment, to oversee execution of the plans; and the water directors form a council in which they, in consultation with the EU's executive body, the Commission, direct preparation and secure agreement of guidance documents—together known as the Common Implementation Strategy (CIS)—in response to questions that arise in the application of the Directive.[12]

Implementation has proved frustratingly difficult. The Directive is ambiguous. Do its protections apply only to the condition of a river basin as a whole, or to every water body within it? Do they apply if there is any deterioration in the quality of a water body measured against its historic baseline, or only when changes require reclassification of overall status, from, say "good" to "moderate"? These ambiguities have only recently been resolved in favor of the more stringent interpretations.[13]

[12] For the guidance documents see http://ec.europa.eu/environment/water/water-framework/facts_figures/guidance_docs_en.htm. For detailed discussion of the CIS as an experimentalist institution at the heart of the WFD see Scott & Holder (2006).

[13] van Rijswick, H. F. M. W., and Ch W. Backes. "Ground breaking landmark case on environmental quality standards?: The consequences of the CJEU 'Weser-judgment'(C-461/13) for water policy

Even more important, effective, inclusive participation of local actors in the definition and continuing revision of the intentionally open-ended goals has been a major stumbling block.[14] The CIS has been revised many times. The WFD will be revised in 2019, among other reasons to reset the penalty default, as it is anticipated that many member states will fail, even with energetic, good-faith efforts, to meet the 2027 deadline.[15]

Ireland's first RBMP was published by the EPA in 2009 and reviewed then and in 2014; a second RBMP, to run until 2021, has recently been adopted (Government of Ireland, 2018) in connection with a fundamental reform of water governance (Daly *et al.*, 2016: 158). Continuing efforts to make the WFD work in Ireland have, as we will see, against many expectations, contributed to important innovations in environmental governance generally, and with regard to agriculture especially.

EU climate change policy, rooted in the UNFCCC model, has in contrast remained at its core peremptory. The 2008 EU Climate and Energy Package and its Effort Sharing Decision allocated the burden to reduce GHG emissions in inverse proportion to national GDP per capita. To help achieve the quota goals the EU also introduced an emissions trading system (ETS), not contemplated in the UNFCCC model, but inspired by related ideas of climate change as a global problem requiring a globally efficient solution. Under the ETS, which excludes agriculture, transportation and buildings, total emissions in large industrial and energy facilities are progressively reduced, and high-cost abaters are in effect forced to buy rights to pollute from low-cost abaters, ensuring that an additional dollar invested in reducing pollution at any facility yields the same, and most efficient, decrease in emissions. (But the ETS, suffering the nearly universal problems of such systems in determining the initial allotments of rights to emit, and periodically adjusting them as conditions change, has been largely ineffective (Vlachouu, 2014; Carney & Hepburn, 2011). The significance of the ETS is

and law and quality standards in EU environmental law." *Journal for European Environmental and Planning Law* 12.3-4 (2015): 363-377.

[14] Hering, Daniel, *et al.,* "The European Water Framework Directive at the age of 10: a critical review of the achievements with recommendations for the future." *Science of the total Environment* 408.19 (2010): 4007-4019; Voulvoulis, Nikolaos, Karl Dominic Arpon, and Theodoros Giakoumis. "The EU Water Framework Directive: From great expectations to problems with implementation." *Science of the Total Environment* 575 (2017): 358-366; Giakoumis, Theodoros, and Nikolaos Voulvoulis. "Progress with the WFD implementation in five European basins: Significant differences but similar problems." *Eur. J. Environ. Sci.* 8 (2018): 44-50;

[15] On the possibilities for expanding the grounds for derogation beyond "natural conditions" while maintaining pressure to strive for compliance see Water Directors Meeting, "The Future of the Water Framework Directive (WFD) – Water Directors input to the fitness check process on experiences and challenges of WFD's implementation and options for the way forward," November 15, 2018.

conceptual—the sway of the ideas it embodies on debate, and potential,the impact it could have were it to work—rather than immediately practical.)

Ireland, along with Denmark and Luxembourg, were the member states assigned the most demanding emissions reduction target—a 20 percent decrease in non-ETS emissions by 2020 relative to 2005. On current projections, Ireland will fall well short. The EPA estimates that by 2020 Ireland's non-ETS emissions will only be between 4 per cent and 6 per cent below 2005 levels. Were the requirements for national emissions reductions to remain unchanged, or the continuing efforts to extend coverage of the ETS to agriculture and other sectors to succeed, , Ireland could face prohibitively high costs of buying compliance in the post-2020 inter-state emissions market.

For these reasons agriculture figures prominently in Irish discussion of the climate change challenge (The Citizens' Assembly, 2018). The sector accounts for over 30 per cent of Ireland's total GHG emissions, while the average for the EU is just over 10 per cent, and 44 per cent of Ireland's non-ETS emissions (EPA, 2018a). The high agricultural share reflects both the lack of heavy industry and the predominance within agriculture of beef and dairy herds. Ruminants are emissions-intensive. Yet measured per unit of milk output, Irish agriculture shares with that in Austria, the lowest carbon footprint in the EU (Leip *et al.*, 2010: 30).

Implicitly Irish policy is to use this latter fact as a mitigation or offset to the dominant place of dairy in national emissions. The argument, evoking a variant of the efficiency logic underpinning the ETS itself, is that, so long as there is a social consensus about the legitimacy of producing some good, such as milk, it should be produced wherever in the world production is most sustainable. Practically, a goal of Irish policy would be to see EU climate change policy on non-ETS emissions reward the lowest carbon dairy producers (the most efficient emissions' abaters) regardless of the member state in which they are domiciled, thereby weakening the grip of national reduction quotas that can arbitrarily penalize the cleanest producers in particular sectors because of the accidents of location. But this argument of course obligates Ireland to stay at the very forefront of sustainable dairying.

3. Four Strands of Recursive Policy and Practice

Facing this shared economic and legal context Irish actors engaged in certification and verification of food production and processing, environmental monitoring and

protection, farming and food production and science and policy have responded in similar and mutually re-enforcing ways: learning, often from failure, the need to adjust—and adjust again—rules to the circumstances of their application; and discovering, as they struggle to do this, the opportunity of collaborating with other actors struggling to do the same. In this part we detail their convergence.

Certifying Grass-based Dairying

Ireland's state agri-food marketing agency, Bord Bia, launched in 2012 Origin Green, a quality and sustainability certification program for the food and drink industry. Broadly inspired by successful efforts from the 1950s to market all Irish butter exports under the Kerrygold label, it was the first national program of its kind in the world. By certifying to concerned consumers that Irish dairy and food products are safe, nutritious, and produced with respect for the environment, the program has helped create a national brand. Audits of firms and farms, originally conceived to check compliance with Origin Green standards became almost immediately inputs to an information platform that aggregates data from many sources to help food producers meet the increasing demands placed on them: an instrument for improvement as much, or more, than for harm reduction. But, in part because of its very success in establishing Ireland as a leader in high-quality, sustainable food production, Origin Green is under strain. Continuing differentiation of consumer taste and confusing ambiguities in the US and elsewhere in the meaning of supposedly reassuring certifications, such as organic, are causing leading Irish dairy producers to consider creating company-specific brands and labels that heighten the demand for more rigorous and precise standards but may weaken the hold of the national system of certification.

The impetus for the creation of Origin Green was an analysis, commissioned by Bord Bia in 2010, highlighting the opportunities afforded by "locally grown, non-polluting, traceable, transparent food" in a world that rebels against "'multinationals' which consumers think are adulterating the food we eat."(Bell & Shelman, 2010: 12). But the report argued that the family farming that made Irish dairy products appealing to consumers could be discredited if even a few farms or firms violated sustainability or quality standards. The report therefore urged creation of a robust system of quality assurance so that the sector could confidently invite potential customers to "come see us: we are open for inspection." While the report suggested private regulation by contracts between companies, Bord Bia preferred a state-led system for setting and verifying compliance with sustainability standards.

Development of the standard began with a review of the requirements of key customers, such as Unilever, and establishment of a Technical Advisory Committee

(TAC) with members from Teagasc, the Food Safety Authority of Ireland, DAFM, and organizations of farmers and food processors. This broad consultation helped balance the aspirations of market leaders and the current capacities of the median farm and firm. In 2013, the TAC produced the Sustainable Dairy Assurance Scheme (SDAS), setting out the criteria the production process must meet to yield "quality" milk.[16] The SDAS meets international standards for standard setting and is registered, through the Irish National Accreditation Board (INAB),[17] with the International Organization for Standardization (ISO).

Under the SDAS, farms are periodically audited for compliance with seven critical criteria (such as providing evidence that that all feed is obtained from quality-assured or DAFM-approved suppliers), and with 60 per cent of the other recommended practices (such as measures for the effective cleaning of the milking parlour). There are 30 sustainability criteria, such as soil testing of acidity and phosphate levels at least every 5 years and recovery of heat generated by refrigeration for other use.[18] Non-compliances are notified to the farmer's primary buyer (termed the nominated milk purchaser)—generally a coop, which may provide technical assistance to help respond to the problem.

The initial criteria of the SDAS reflected the need for compromise among the sectoral stakeholders involved in the program's design, and especially for broad acceptance among farmers with a wide range of capacities. But, to credibly verify Ireland's sustainability claims in an ever more demanding environment Origin Green must, and does, apply the current standard more and more rigorously while ratcheting up the criteria required for certification. The drive for improvement takes three forms.

First, there is a focus on ensuring maximum compliance with the existing standard. The national compliance rate in 2017 was 84 per cent. In some co-operatives it was virtually 100 per cent in 2018. High compliance rates demonstrate the practicality of the requirements; noncompliance has come to be seen as a sign of irresponsible or unneighborly behavior, or sheer incompetence; and it is becoming socially acceptable for purchasers to penalize farmers who do not meet Origin Green

[16] Under the assurance schemes for beef, sheep and dairy all farms are subject to an independent audit every 18 months and spot audits can take place at other times. Approximately 800 audits, each of which takes about 2-2.5 hours, take place each week, using around 120 contracted staff.

[17] INAB accredits laboratories, certification bodies and inspection bodies in accordance with the ISO 17000 series of standards and guides. See www.inab.ie.

[18] Information collected on these criteria is used to calculate a sustainability performance for the farm but is not used in the calculation of the audit score.

standards. Glanbia, for instance, now pays suppliers without certification 5 cent less per litre of milk.

Second, as required for continuing ISO accreditation, the standard is reviewed every 3 to 5 years. Bord Bia is currently revising the SDAS (January 2019), drawing on a desk review of the existing requirements and impact on farms; research with the SDAS auditors; comparisons with international programmes (such as the British Red Tractor standard); Bord Bia's own market research, Teagasc research findings and changes in legislation. The revision is to be completed in 2019.

The third and most ambitious development of the standard is its transformation into an information platform to help individual farmers improve their economic and environmental performance. Even as Origin Green was taking shape Board Bia, working with Teagasc and the Carbon Trust—a British firm with expertise in the calculation of carbon footprints—realized that the data on length of the grazing season, animal feeds, usage of fertilizer and other chemicals, management of manure and the like, collected by audit, would be immeasurably more useful if combined with the information in other, existing, data bases: the real time, lifetime profile for each animal in every herd in DAFM's Animal Identification and Movement database; the data on calving rates and intervals, weight by age and mortality and replacement rates collected by the Irish Cattle Breeding Federation; and the milk volumes and quality measures recorded the by nominated milk purchaser.[19] Before Origin Green was formally launched in 2014 pooling arrangements were in place; and with the farmer's permission the data from the various sources are integrated during the audit, on a handheld device, to generate estimates of environmental impact and productivity benchmarked to the farmer's earlier results and those of peer neighbors. Mining this data in collaboration with Teagasc, the Irish Biodiversity Data Centre and other organizations, Bord Bia is working to provide farmers with detailed status reports on their carbon footprint, grassland management, soil quality and bio-diversity, as well as their rank on various metrics compared to the best and worst performers by region or soil type. Its role as the keeper of this data make Bord Bia, in the medium and long term, an indispensable partner in all tool building and extension efforts aimed at farm-level improvement.

In the short term, however, Origin Green and similar systems of certification for food are coming under strain due in part to their very success. Labels that until recently signified high-quality, safe and nutritious food, command consumer confidence and help create lucrative markers. This, in turn, attracts new entrants, including sharp

[19] https://www.agridata.ie/publicdocs/SDAS_Standard.pdf

operators who use the many ambiguities in the standards to market products that comply with formal requirements, but flaunt the ethical commitments those requirements are meant to embody. For example, the 'organic' label in the US as applied to dairy requires that only 30 per cent of cows' nutrients come from grass, and that cows have free access to grass for only 120 days per year (USDA Organic, 2013). This, and further loopholes in the standard, allow producers with herds of up to 10,000 cows, kept under highly confined conditions, to produce milk sold as organic (Whoriskey, 2017). The resulting confusion of consumers is compounded by the proliferation of other labels, such as 'non-GMO,' reflecting cultural and scientific differences about what counts as quality. This confusion is all the more significant for Irish producers, whose growing emphasis on the "grass-fed" nature of their product makes them acutely aware that Bord Bia's Origin Green strand never precisely specified the meaning of the term, or the essential qualities associated with it.

As a first step towards reassuring consumers and limiting abuse of the standard Teagasc, supported by Bord Bia, is quantifying the level of grass in the Irish variant of the grass-fed diet, using data from the SDAS audit (Shalloo, *et al.,* 2018). The next step will be the development, alongside Origin Green, of an internationally recognised, stand-alone grass-fed standard with biochemical, nutritional and subjective components ensuring that grass-fed dairying looks the way the consumer imagines it would (*ibid*.: 5).

These efforts are partly driven by, but also partly in tension with, the determination of some of the most expansive and self-confident Irish coops to define new consumer categories and brands, and corresponding standards, that respond to the growing demand for healthy, safe, naturally-produced dairy products, while avoiding entanglement with current certifications. Glanbia, for example, has created a new brand called Truly Grass-Fed, directed to the new market category of "conscious consumers," who want to be able to inform themselves about the products they buy and are especially attentive to the aspects of animal welfare and social conditions of production captured in the idea of the family farm passed down from generation to generation. Products could only be called truly grass-feed if the herd grazed outdoors 300 days a year, averaged over 3 years, if the growth of cows was not accelerated by hormones, and if purchased feed meets the non-GMO standard in the US (though not the stricter EU standard).

Bord Bia, obligated to accommodate the median food organization, is unlikely to accept definitions of grass-fed that can only be realised by those providers based in the most favored parts of Ireland. Whether Bord Bia's new grass-fed certification will be truly national, or a national baseline upon which expansive coops will build

company-specific brands with distinctively demanding specifications, is an open question.

But there are limits to these fissiparous tendencies. Very demanding standards can produce internal differentiation within the coops themselves, with the attendant problems of managing relations between owner members who do and don't clear the new hurdles. Glanbia is helping train a club of particularly capable farmers to supply Truly Grass-Fed milk; and the lessons of that experience will presumably be used either to increase member capabilities or reappraise the ambition of the standard—and most likely some combination of both.

Perhaps more importantly, some aspects of the sustainability claims intrinsic to the notion of grass-fed counsel against company-specific initiatives that might isolate a coop from its rural context. Glanbia and other similarly situated coops understand that protecting water quality and reducing GHG emissions are as important to the integrity of their brand as the length of their grazing season or the veterinary regime, and that success in environmental protection requires extensive collaboration with many local actors, for instance in increasing use of renewable energy. For these reasons, the drive for differentiation of standards will likely be tempered by an expanded commitment to collaboration between the coop and its members to build capacity, and between the coop and its competitors and neighbors to secure conditions of production to renew the very fabric of rural society.

Managing Water Quality at the Catchment Level

Despite significant investment, water quality did not appreciably improve during the first river basin plan cycle, from 2009 to 2015.[20] This failure triggered a number of distinct, but informally linked, programs to intensify monitoring under the Nitrates and Water Framework directives and improve local response to the problems detected[21]. These programs create a web of institutions that is coming to function as

[20] Duggan estimates that €8bn was invested by government departments, farmers and companies on farm buildings, wastewater treatment facilities and agri-environmental schemes (Duggan, 2015). Research in 2010-2012 showed that half of all water bodies were at less than good ecological status and, therefore, not meeting the objectives of the WFD (Bradley *et al.*, 2015; EPA, 2016). The 2010 OECD review of Ireland's environmental policy noted the tardy implementation of the Nitrates Directive and that the rate of progress was unlikely to prove sufficient to meet the WFD goals for 2015 (OECD, 2010; see also Flynn and Kroger, 2003).

[21] Research on the implementation of the Nitrates Directives in Ireland shows that a significant number of farmers were unconvinced of the validity of the measures and felt there was a lack of scientific evidence on the link between temporal farm practices and the impact on watercourses due to the complexity of the pathways involved and the variety of soil and hydrological conditions (Buckley, 2012).

an integrated system of governance for better control of nutrient runoff and water quality at the catchment level, greatly expanding public participation in environmental decision making in the process.

Teagasc established the Agricultural Catchments Programme (ACP) in 2008, in preparation for the EU's review in 2013 of Irish performance under the Nitrates Directive. Like other EU member states with intensive agriculture, Ireland qualified for a derogation from some of the requirements of the original Directive.[22] Continued qualification would require demonstration of the ability to limit the diffusion of nutrient impacts beyond the source zone. To support this, Teagasc, under the ACP, selected six catchment areas[23], differing in soil types, geology and types of farming, to monitor and model the relations among farm management practices[24], the transfer of nutrients from their source to various water receptors and changes in water quality. Some 300 farmers participated in the program.

Each catchment is supported by an ACP advisor, essentially a Teagasc extension agent with a much reduced case load to allow more intensive collaboration with individual farmers, and a technician, to maintain monitoring equipment, collect data and assist with research. Drawing when necessary on the additional expertise of the 15 researchers on the Teagasc ACP staff, the advisor works closely with each farmer in the catchment to develop a nutrient management plan, starting with detailed baseline data on nutrient inputs from farm yards (point sources) and field sources (diffuse losses). The goal is to improve environmental outcomes, if possible at no cost to economic performance, and ideally—when more efficient use of nutrients reduces both pollution and input costs—with a gain.

A key finding of the second phase of the ACP (running from 2012-2015) is that variations in soil and subsoil types, and the underlying geology are so influential in the absorption and drainage of nutrients that general rules of nutrient management, and of course plans based on them, are likely to fail their purpose. For example, poorly drained fields with phosphorus values so low they pose an agronomic risk, but seem environmentally innocuous, may nonetheless be a source of pollution through

[22] This allows farmers to exceed the 170kg/ha limit for organic nitrogen (N) from livestock manure, up to a limit of 250kg/ha organic N.

[23] Five of the catchments were of a similar size, between 6 and 12 km2. One larger catchment, 36km2, was chosen to examine the impact of measures on free-draining, shallow soils over karstified limestone.

[24] The first phase of the ACP focused on a specific set of measures—nitrogen and phosphorous usage and closed periods when slurry could not be spread. This ensured that those measures could be scientifically evaluated. As the programme evolved new measures, for example exclusion of bovines to watercourses and the placement of drinking points, have been added.

fast surface runoff. Conversely, well drained soils with phosphorus values in excess of agronomic needs may, despite appearances, pose negligible risk of pollution. (Shortle & Jordan, 2017: 17)

The policy implication is that a nutrient management plan should be a starting point or provisional guide for investigation, farm by farm, and by farmer and advisor together, of the particular circumstances that create environmental risks, and how most economically to address them. The report on phase two of the ACP explicitly rejects a "'one size fits all' approach to how land and nutrient inputs are managed" and observes that even user-friendly plans—in the sense of a convenient presentation of the relevant good practices—"on their own will not meet the farmer's needs and to increase their effectiveness." In the best case, "advisory support is required to help with implementation'' (Shortle & Jordan, 2017: 17). It would be only a slight exaggeration to say that the implementation is the plan, and it is co-produced by the advisor and farmer, collaborating in precisely identifying the problems of particular farms, devising remedies, and jointly monitoring the results. (Burgess, phone interview, October, 2018).

Results in the Timoleague catchment in West Cork, underscored in the phase two report, suggest the potential effectiveness of this contextualizing approach. Timoleague was the only catchment in the program dominated by intensive dairying. It was also the only one in which farmers demonstrated mastery of nutrient flows—by raising phosphorus levels in fields where they were too low and lowering them in fields where they were too high— while achieving, again uniquely, subtle but discernible improvements in the quality of water flows (Shortle & Jordan, 2017: 16).

The ACP advisor seems to have played a key role in achieving these results, both by collaborating extensively with farmers and connecting them individually, and as a catchment group, to other experts.[25] The advisor was also the catchment's program technician—one of only two advisors with this dual function. This continuing connection, as well as the advisor's own broad interests, kept him in close contact with the ACP technical staff, which he integrated into his consultations with individual farmers from the start. In part because of the association with the technical staff, the advisor understood the contextualization of nutrient management broadly, paying special attention to monitoring soil quality by frequent testing. In his view "the ACP was as much a soil science project as a water project" (Dermot Leahy interview, October, 2018).

[25] On the Timoleague catchment and a self presentation of advisor-farmer collaboration there see Leahy & Walsh, 2015, https://www.teagasc.ie/media/website/publications/2015/Leahy_Walsh.pdf.

These practices surely contributed to Timoleague's unique success in nutrient management, but by how much is indeterminate. The ACP program design did not control for the demographic characteristics of the participating farmers. The Timoleague dairy farmers are, in relation to participants elsewhere, disproportionally young, well-educated and—given their capacity to earn good incomes while some pay the high land rents in the district—capable. These characteristics also contributed, along with the adviser's engagement and the further collaboration it enabled, to Timoleague's success in managing nutrients, and for now there is no estimation of the balance of influence.

Though the ACP spurred reconsideration of the role of the extension agent, and Teagasc continues to participate in innovative technical support projects with partner organizations and the coops, these experiences have not resulted in anything like a comprehensive reform of the extension service[26]. It was, rather, the EPA, together with the local authorities, that took the lead in developing the ACP's central finding of the need to engage local actors in tailoring mitigation to their conditions, and in translating that understanding into governance institutions to make contextualized management of water quality at the local level possible.

Responding to its obligations under the WFD, the EPA established, in 2013, a new Catchment Science and Management Unit (CSMU). This built on and complemented the work of the ACP. Once more, the emphasis was on deepening understanding of the mechanisms by which, in particular landscapes, nutrients and other pollutants were transported from their source to the water bodies and other receptors they damage: disrupting the pathways by which pollution travelled was often a more effective means of mitigation than eliminating pollution at its source or containing its effects at the receptor. It was emblematic of this focus on the particulars of the physical substrate of catchment areas, largely absent in the view of the EPA from the WFD in its successive iterations, that the scientists recruited to the CSMU were primarily from the physical, not biological sciences (EPA, 2018b). The new recruits worked with the EPA's team of aquatic biologists to implement the ecological monitoring program.

[26] Having focused on cost minimisation and diversification during the quota era, Ireland's extension services were expanded from 2008 and, using farmer discussion groups, shifted the emphasis to herd expansion, intensification and dairy specialisation (Lapple *et. al.* 2019). While research confirms their role in inducing these adjustments in the dairy sector, the role of the extension system's advice in shaping sustainability, especially water quality, 'also need to be addressed and updated' (op. cit. 21).

The new catchment units were part of a larger effort by the EPA and its partner institutions in water quality management to establish a process to assure that priorities for intervention are agreed with key stakeholders and that the agreed interventions are executed with the fullest possible participation of the affected actors on the ground. That process, carried out for the first time between 2015 and 2017, proceeded in four steps[27].

First, the EPA characterized water quality at the catchment level (400-3500km2) by aggregating finer-grained data on water bodies (10-30km2) and sub-catchments (3-7 waterbodies) (Deakin, 2015). In the second phase, EPA, with the participation of Inland Fisheries ran a series of workshops for each Local Authority to discuss, waterbody by waterbody, all water quality issues. This ensured early incorporation of local knowledge in assessment of pressures. Third, the EPA and the newly-established water units at local level jointly ran five regional workshops with all public bodies to discuss current and future potential measures, and to agree on the likely target dates. These regional workshops selected 190 priority areas for action.

In the fourth phase the priority areas are subjected to "local catchment assessments": field-level examinations by the local actors themselves of the source of pollution in given water bodies (Daly, 2016). This assessment determines the local work plan, specifying, costing and prioritizing projects. Such collaborative determination of priorities is particularly important in rural areas, where there are multiple, potentially significant small point pressures and diffuse sources of pollution (Daly *et al.*, 2016: 161), and deep local knowledge is indispensable to a deliberate and consensual choice of which problems to attack and in what order.

As the conception of projects shades into, and is influenced by, the prospects of their execution in this fourth phase, the selection process engages new, local governance institutions created in large measure to provide technical support for, and foster inclusive participation in, deliberative decision making. The centerpiece of the new governance structure is the Local Authority Water and Communities Programme (LAWPRO), a shared service between all local authorities, established in 2016. It was created to meet new requirements for improved, ground-level management capacity of the revised WFD and to help put into practice the need for deep contextualization of local interventions indicated by the findings of the ACP and CSMU. LAWPRO's purposes are to increase public engagement in the formulation of RBMPs by fostering consultation with stakeholders within and across communities and to

[27] The revised approach to the WFD was outlined by government in 2014 (DECLG, 2014) and is described in the recently published second RBMP (Government of Ireland, 2018, 119-121)

provide technical and other assistance to local authorities, community and voluntary groups in this and other matters related to water management. A Waters Catchment Assessment Team, composed of 35 scientists with a wide range of expertise, and grouped in five regional offices, collaborates with 12 community water officers in providing technical support in project selection.[28]

When field investigations reveal problems arising from agriculture, the local assessment teams refer them to another newly-created entity: the Agricultural Sustainability Support and Advisory Programme (ASSAP). The ASSAP links contextualization of water management at the catchment or territorial level to contextualization of nutrient management and other pollution mitigation measures on the farm. Formed in 2017, the ASSAP is jointly funded by two government departments and the coops through their trade association, Dairy Industry Ireland (DII). It has a staff of 30 Agricultural Sustainability Advisors, 20 employed by Teagasc, the remainder by the coops, and all recently trained according to a curriculum developed by the EPA, Teagasc and other public bodies. In consultation with the assessment team the ASSAP advisors work with farmers implicated in local environmental problems to improve land, farmyard and nutrient management as needed.[29] ASSAP's function as a lynchpin of the new governance structure is reflected in the composition of its own governing board, which includes Teagasc, LAWPRO and the DII.[30]

Towards Precision Pasture and Nutrient Management

Advanced agriculture is converging with advanced industry. Both take for granted that current production arrangements inevitably embed faulty or inapt assumptions, or defects in their application. Both respond by making organization deliberately fragile, so that strains produce conspicuous disruptions, and disruptions trigger investigations that point to the currently most constraining defects in design or execution. In industry this general response is often associated with lean production: a system of manufacturing that eliminates the buffers or reserves that, in a

[28] For a good overview of the role of the Waters Catchment Assessment Team and its place in the new governance structure see https://www.catchments.ie/the-local-authority-waters-programme-catchment-assessment-team/.

[29] on ASSAP see https://www.teagasc.ie/environment/water-quality/farming-for-water-quality---assap/

[30] A measure of the political sensitivities aroused by this wave of institutional innovation is the formation of a Farm Engagement Group, with the senior elected representatives of the four main farming organizations, together with representatives of LAWPRO, Teagasc and the DII to address the teething problems of ASSAP.

traditional assembly line, would conceal interruptions in the flow of work, and then empowers front-line workers to respond immediately to breakdowns and help identify and eliminate their cause. In farming, the ensemble of related organizational and technological innovations is called precision agriculture.

A shift in this direction is evident in the coops' and farming organisations' growing concern for their own and their members' ability to identify and correct shortfalls through reorganization and, if need be, adoption of new techniques. As the large coops have come to see increasingly demanding quality and environmental standards as a competitive advantage, they have become increasingly rigorous in their own production practices and ever more dependent on their members' ability to keep pace. Hence their increased investment in the kind of supplier development or capacity building in precision practices that is routine in advanced industry.

Dairygold, for example, in collaboration with Enterprise Ireland, the state industrial policy agency, introduced lean manufacturing in its processing and related operating functions in 2011. Six years later, with assistance from Teagasc, it extended participation to a pilot group of farmers of varying herd size. The program, called Leanfarm, is now available to all members of the co-operative. The Glanbia Open Source Dairy program, the Carbery Greener Dairy Farm Projects and the Smart Farming programme, initiated jointly by the Irish Farmers Association and the EPA,similarly seek to both improve carbon footprint and optimize resource allocation; and DII has launched a related pilot program.

An early innovation in the use of information technology, induced by and contributing to this approach, is the Carbon Navigator. Developed by Teagasc and Bord Bia, the Navigator focuses attention on 'distance to target' by comparing a farm's current performance with the average and best performing farms operating under similar geo-environmental conditions (typically in the same geographic neighborhood) (Murphy *et al.*, 2013). It identifies a range of possibilities for reducing GHG emissions while increasing yields and/or reducing costs and allows farmers to set targets to be achieved over a 3-year period. When first introduced, in 2012, the Carbon Navigator helped demonstrate the feasibility and advantages of GHG reductions to a large number of front-line actors. Its use is now a condition of eligibility for many DAFM programs.

But the application of precision-agriculture techniques to daily, and especially grass-based dairy[31] (Shalloo *et al.*, 2018: 263) has been slow. To accelerate development big data tools to improve the quantity and quality of grass and improve the cows' use of nutritional resources Teagasc established PastureBase Ireland (PBI) (Hanrahan *et al.,* 2017) in 2013. Each of the 3,000 dairy farmers (roughly one sixth of the total) participating in PBI enter weekly data on grass cover at the paddock level, based on visual estimations or measuring equipment, as well as information on cow numbers and purchased nutrients. Combined with paddock-level data on soil type and quality, drainage, re-seeding dates and cultivars, fertiliser use and calving dates (an important determinant in the demand for grass) this information allows estimation (accessible on smart phone) of daily pasture growth rates by paddock and farm—in itself a valuable support day-to-day decision making[32] (Shalloo *et al.,* 2011 and Shalloo *et al.,* 2018).

As often happens when such comprehensive and rigorous analysis is applied to areas of decision making long dominated by expertise ingrained in habit, verities have been overthrown. That grass grows richly in South and East of Ireland, and poorly in the Midlands and West has historically been a defining feature of Irish agrarian, economic and social life. PBI results show that the differences today, at least, are much exaggerated; that the potential for a substantial increase in grass yield is much higher in the traditionally disfavored regions then in the old heartland of dairy; and, to judge by the difference in regional rents, the potential for improvement is not only overlooked but greatly undervalued.[33] A sub-sample of 75 larger farms (average 34 paddocks) shows that variation in grass yield across paddocks within farms is greater than the variation between farms, immediately suggesting potential for improvement (Hanrahan *et al.,* 2017: 199).

Further progress towards precision dairy will be housed in VistaMilk[34], a new research center jointly funded by Science Foundation Ireland, the country's main science funding body, DAFM and actors in agribusiness, including the main coops, and IT firms. It operates under aegis of Teagasc in partnership with a number of Ireland's leading technology research institutes. VistaMilk focuses on using networked, sensor data and machine learning to improve pasture-based dairy

[31] Slower diffusion reflects the costs of connectivity across large grazing platforms; the relatively small size of the potential global market, reducing entrepreneurial interest in creating new technologies; and pressures to lower capital expenditure (Shalloo *et al.*, 2018: 263)

[32] PBI outputs have been cross-checked with actual outputs on research farms and been found to accurately estimate dry matter yields (Hanrahan *et al.*, 2017).

[33] Interview with Laurence Shalloo, January 15, 2019. See also Hanrahan *et al.,* 2017: 200.

[34] http://www.sfi.ie/sfi-research-centres/vistamilk/

production, for example improving the accuracy of predictions of grass growth by linking historical and real-time grass-growth and meteorological data.

Teagasc's lead role in the drive towards precision dairy is an additional, perhaps in the medium term decisive, prod to reconsider the role of its advisory services. Those building the precision-dairy platforms emphasize that the new tools will only be useful if they address needs arising directly from farmers' experience, and the data-rich answers they provide to those questions will only in turn be useful if interpreted jointly by farmer and the extension expert. The need for co-production of improvement plans will if anything increase (Shalloo interview, 2019). Put another way, and with an eye to much current discussion of machine learning and related technologies, in precision dairy at least the faith that artificial intelligence will automate complex decision making is as misplaced as the traditional confidence that the role of an extension service is primarily divulgation of scientifically proven practices and technologies.

Science as a Tool for Local Action

Like the typical state agricultural extension service, Teagasc does research at the hinge between fundamental and applied science and advises farmers on the introduction of superior techniques. But, again like the typical national extension service, Teagasc also addresses large questions of policy, such as the response of Irish agriculture to the national obligation to reduce emissions, and in this way has come to play a key role at both national and international level in the evolution of thinking on the subject. While it is widely recognized within Teagasc that the pace and scope of change require reassessment of traditional extension services, reform has been mostly limited to innovative partnerships with the coops or the EPA, as noted above. In policy thinking, and the practical proposals that follow from it, Teagasc has, however, in incremental steps undergone a radical change.

A decade ago Teagasc's response on climate change was cautious, verging on defensive. It proposed a few mitigation strategies, all to be applied country wide, and ranked them, authoritatively, in decreasing order of cost effectiveness. Today Teagasc, in collaboration with peer agencies in a number of EU member states, emphasizes the diversity of settings within agriculture in every country; the need therefore to adjust proposed policies to local conditions; and the advisability, in view of this need for careful contextualization, to treat policy proposals as prompts and tools for local determination of strategy (resulting perhaps in revisions of broader conceptions of what works), not pre-emptively incontrovertible instructions in cost-efficient measures. This reorientation has been accompanied by new instruments for

self-assessment and improvement of environmental performance for farmers and their advisors.

Teagasc's initial, cautious response to climate change mitigation is documented in the way it, together with DAFM, framed agriculture's contribution to an inter-departmental Preferred Policy Measures Group on climate change policy in 2008-9. Teagasc and DAFM emphasized the difficulty of reducing GHGs in Irish agriculture and sought to shelter Ireland from pressures for immediate action in climate change, invoking the need to balance concern with emissions reduction with concern for global food security. It identified a few mitigation options, such as changes in the grazing season, nitrogen use and slurry spreading.

In 2012, the Teagasc Working Group on Greenhouse Gas Emissions produced a marginal abatement cost curve (MACC) for Irish agriculture (Schulte & Donnellan, 2012). MACCs are usually presented as bar graphs, in which the width of each bar represents the effectiveness of a given mitigation measure (measured say in tons of carbon emissions avoided each year)and the height of the bar represents its costs (negative if there are net savings from the elimination of polluting waste, positive if the abatement measures do not pay for themselves). Ordering the policies by the height of the bar, from those that save the most to those that cost the most, is a convenient way of highlighting the cost effectiveness of alternative mitigation actions. To the hurried reader Ireland's agriculture sector MACC simply ranks the attractiveness of mitigation actions with an aura of conclusive objectivity. It says what Ireland should in this domain do.

Since 2012, the presentation of MACC curves by Teagasc has changed dramatically, reflecting and crystallizing an about face in the approach to climate change policy in their EU policy and scientific communities. Teagasc staff took the lead in convening six teams from EU member states to review this turnaround in the construction and conception of agricultural MACCs (Eory *et al.*, 2018). The central theme in exchanges among the teams was the need to move from high levels of aggregation to the recognition of heterogeneity in climate, soil and hydrological conditions, and the need to differentiate mitigation strategies accordingly. The average farm, as identified in aggregate national data, is unlikely to be a typical farm in any useful sense, but should be seen, politely, as a "virtual farm": a statistical artifact not observed in reality (Louchichi *et al.*, 2010). The suggestion, consequently, is "to reduce the uncertainty related to heterogeneity" by using "a disaggregated

approach," using data from multiple sources and on a wide range of variables (Eory *et al.*, 2018: 708).[35]

A summary of the group's findings repudiates the conventional view of MACCs and the policy and scientific understandings informing them:

> As authors and users of agricultural MACCs, we have learnt to appreciate the main purpose of engineering MACCs, which is not necessarily the accurate prediction of the total abatement potential and associated costs. Instead, their main purpose is to provide a coherent forum for the extremely complex discussions surrounding agricultural GHG mitigation, and to visualise opportunities and low hanging fruit in a single graphic and manuscript (Eory *et al.*, 2018: 714).

The implications for participation are clear. Because "the journey of developing a MACC is at least as important as the final product," evaluations of policy alternatives are most effective "when all actors are involved in the development of MACCs from the start, including both disciplinary and generalist researchers, policy makers, measurement, reporting and verification experts and practitioners' (*ibid.*). MACCs are to become an instrument for highly-contextualized exploration, implementation and assessment of mitigation possibilities rather than a tool for illustrating established results.

4. Contextualization, Collaboration and Penalty Defaults

In the face of uncertainty, Irish environmental regulators, dairy coops and dairy farmers discovered the need to adapt rules and practices to local conditions and are building, together, institutions to govern this contextualization, opening it's stakeholder participation and ensuring that generalizable results are incorporated into the framework that guides overall action. Learning and institutional innovation was more often than not impelled by failure. Nutrient management plans too often failed to reduce pollution or improve soil quality. River basin management plans did not improve the status of water bodies. Factors not contemplated in the plans were confounding the results. Efforts to grasp what was omitted led to the discovery of

[35] Likewise, recent research on options for "climate smart land management" for Atlantic economies suggested that the cost-effectiveness of land use and land management options may be improved if management strategies are customised for contrasting soil types (Schulte *et al.*, 2016). This creates the prospect of 'functional land management', in which enhanced data about soils might have implications for the overall approach to agricultural and social policy in marginal rural areas.

irreducible local complexity: varieties of soil, sub-soil and geology combining in idiosyncratic ways with one another and farming practices to create distinctive problems and the potential for correspondingly particular solutions. Rules, by their general nature, cannot master this idiosyncrasy; a governance process, like LAWPRO, that organizes and reviews local investigation and resolution of local problems, can. Once they became aware of the relations among productivity, environmental protection and soil quality inherent in the grass-fed model, coops and dairy farmers quickly arrived at the same conclusion.

Contextualization induces collaboration. To recognize the need for contextualization—the relevance of factors unthinkingly omitted from initial directives—is at once to acknowledge the limits of one's ken and jurisdiction and the possibility that other organizations, with distinctive expertise and authority, can help meet the deficiency. Full recognition of local complexity makes collaboration imperative, to share the costs of searching for root causes and, as the example of ASSAP shows, in the certain expectation that solutions will often require collaboration across jurisdictional boundaries.

But contextualization and cooperation are not the whole story. Taken by themselves they suggest, misleadingly, that Irish institutions developed almost naturally—as farms, firms and regulators evolved under uncertainty, without an architect or master builder, perhaps without deliberate human direction at all.

What is missing from this telling is the role of political will expressed in penalty defaults. The Nitrates Directive required the formulation of NMPs, and their continuing improvement, to qualify for derogation from immediate application of the Directive in full. The WFD required collaborative articulation of river basin plans, and continuing improvements in the participatory process by which those plans are generated and in the results they achieve. The consequences for obstinate or bad faith refusal to respond to these requirements are potentially draconian: exclusion from the community of producers and the support and dignity membership affords—a penalty default. The threat of a penalty default made dogged defense of the status quo risky. It created powerful incentives for the investigation of catchments that established local idiosyncrasy as an assumption of organizational design, not a confounding factor in planning, and made local revision of high-level plans a central strategy, not an informal coping mechanism. If Irish institutions evolved, their evolution was given direction by political will, and the results, as much evident in the ongoing revision of the Origin Green standards and the contracts between coops and members as in LAWPRO, will influence subsequent political and economic choices.

It is in the setting of these penalty defaults, then, that contextualization and collaboration under uncertainty have generated distinctive forms of production and a corresponding regime of environmental regulation. Just what kind of regime that is, and how its example can help us past the current impasse in climate change governance, is the subject of the last section.

5. Self Organization under Deliberate Direction: New Possibilities for a Climate Change Regime

In top-down regimes the parties—in theory all the nations of the globe—agree to achieve certain goals in climate-change mitigation, and establish procedures to review progress and hold themselves accountable to their commitments. The immediate appeal of the approach is to offer a tangible global solution to an indisputably global problem. Its defect is that a workable agreement supposes the very knowledge of how, and at what cost, mitigation can be achieved that uncertainty precludes. If a party to a comprehensive agreement can't estimate the costs of its commitments, and fears others can't as well, it commits only to what will be done in any case. That is the lesson of experience as much as logic. The top-down approach, which dominated governance of climate change since its inception in the 1980s, was repudiated, largely for this reason, in the Paris meeting of the parties to the UNFCCC in 2015 in favor of some bottom-up alternative.[36]

The bottom-up approach emphasizes the actors' capacity for self organization: their ability, left (almost) to themselves to solve the problems they face. Its immediate appeal is to license and incentivize initiative and innovation—to encourage the actors to learn what they need to know, given uncertainty. But, at least as envisaged in current theory, bottom-up approaches work only under such restrictive and exceptional conditions that they are unlikely to be of practical use at all.

In one variant, the precondition for cooperative problem solving is isolation from the world, so the actors are left alone to learn from the costs of selfish action and the benefits of coordination: Soldiers, war weary in a trench, spontaneously cease fire, and the soldiers on the other side, equally weary, follow suite. The truce holds so long as superiors don't threaten discipline or reactivate the obligations of honor. By the same logic, farmers on a remote mountain or inhospitable plateau will, given

[36] See for reviews of the current discussion Oberthür, Sebastian. "Reflections on global climate politics post Paris: power, interests and polycentricity." *The International Spectator* 51.4 (2016): 80-94.

enough time, devise rules for sustainably sharing the grass and water on which they depend, averting a collectively destructive race amongst them all to seize as much of the commons as possible, for fear that—absent assured shares—each of the others will be attempting the same. But today's world is of course deeply interconnected; if isolation is the condition for learning, we will not learn.[37]

In a second variant the solution to the mitigation problem is supposed to be known—it's a carbon tax—and the obstacle to self organization is a collective action problem: Groups or clubs of nations are willing to tax themselves to advantage de-carbonization. But they fear that outsiders, aware that no one can be excluded from the benefits of improvement in the global public good of climate, will not tax themselves, preferring to free ride on the dues of the club members, thus endangering the whole undertaking and causing the volunteers to withdraw their commitments. The solution would be an agreement among club members to impose tariffs on the imports of non-members. Set at the right rate, the tariff would be costly enough to the outsiders that they would do better by taxing carbon themselves and joining the club (Nordhaus, 2015). But the essentials of the club idea, the minimum effective level of the carbon tax and the tariff rate, depend on highly complex and contestable calculations by experts—on reliance, that is, on technocratic expertise that is now, understandably, broadly in question. Relying on such expertise would be at best a calculated gamble.

Recursive governance, as exemplified in Irish developments, combines the authorization and encouragement of self organization, in the sense of the local learning and problem solving of the bottom-up approach, with the on-going review of ground-level decisions by more encompassing authority associated with top-down governance. But recursive governance is not, for that, a hybrid of the two familiar forms. It integrates distinctive variants of elements of both, in distinctive ways, to form a novel type of governance suited to addressing the uncertainties of climate change and related problems under the conditions we actually face, and with the institutional resources we are in the progress of constructing.[38]

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[37] For an effort to apply a less stringent variant of this approach, associated with the work of Elinor Ostrom, to conceptualizing a post-Paris climate change regime see Jordan, Andrew, *et al.,* eds. *Governing Climate Change: Polycentricity in Action?.* Cambridge University Press, 2018.

[38] Hayek, developing a line of thought that traces back to Adam Ferguson and Edmund Burke, distinguishes "spontaneous orders," such as law and language, which result from human action, but not human design, from instutions created by deliberate calculation, for example through legislation. Hayek, Friedrich A. "Law, legislation and liberty. Vol. 1: Rules and order." (1973). The regimes under discussion here attempt to orient action while renouncing any pretension to design particular outcomes. For an itinial application to climate change post Paris see Sabel,

The penalty default, for example, like the proposed tariff on imports from non-members of the carbon tax club, addresses a general incentive problem. If the status quo is too easily defended, pioneering innovators will struggle to find a following, and their ingenuity is more likely to be punished than rewarded. The penalty default makes adherence to the status quo risky, not safe, and encourages the kind of investigation that leads to innovation and discovery. But, unlike its bottom-up homologue, the penalty default is easily designed: it states only a very general goal—"good water" in the case of the WFD—and it sanctions only defiant or deliberately deceptive adherence to the status quo, not good-faith failure to achieve any particular target. Moreover, the penalty default incentivizes learning, not simply coordination on an agreed solution. In these ways, it is the kind of sanction of which uncertainty admits.

Or consider contextualization. The recognition of the need for local solutions to idiosyncratic local problems is of a piece with bottom-up self organization. But contexualition is a corrective and supplement to higher-level decision making and procedures, not a substitute for them. LAWPRO review modifies the specification of local targets identified by national and regional review, and how and in what order they are to approached. Local authorities and stakeholders are not free to disregard the national list—or to insist that their interventions, whatever the outcome, are unquestionable solely because they have been locally authorized.

In that local decisions are framed and reviewed by higher authority we might see a similarity between recursive and top-down governance. Yet in this connection too there is a crucial difference. Top-down governance, as its name indicates, is hierarchical and closed: instructions pass, in increasingly detailed form, from the apex of the hierarchy to its base and the boundaries of the organization sharply drawn, separating insiders, whatever their rank, from outsiders. In experimentalist governance, as contextualization shows, lower levels correct higher levels and vice versa, and organizational boundaries are porous. Authority is shifting and contestable, not lodged in a single, commanding place.

Precisely because local autonomy is embedded in larger structures, but not subordinated to them, local innovations in substance and process can pass to the regime as a whole. The WFD is a striking example. The Irish EPA has learned much about water management from other EU member states. Now the EPA will learn from and with LAWPRO, better ways to organize inclusive stakeholder review of

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Charles F., and David G. Victor. "Governing global problems under uncertainty: making bottom-up climate policy work." *Climatic Change* 144.1 (2017): 15-27.

pollution problems, and better ways to address some types of pollution; and the other member states will have the benefit of these exchanges. And though the EU, because of the member states' need to jointly assess and draw conclusions from their distinct regulatory arrangements, is especially adept at organizing such informative reviews, many widely-admired international organizations—focusing, for example, on the regulation of particular pollutants (the Montreal Protocol on the elimination of ozone-depleting substances) (De Búrca, Gráinne, *et al.*, 2014), or the protection of particular species (Inter-American Tropical Tuna Commission and the Dolphin Conservation Program) (Sabel and Simon, 2012)—do the same.

So the example of developments in the Irish dairy industry, though but an example, is a case of possibly general application. Shaped by political will—the determination to protect the environment—yet formed in detail by prudent responses to a thousand constraints, without plan or master builder, its very existence invites us to consider an improbably hopeful possibility: Might it be that, in the moment of our need, we happened to create the novel organizational resources with which to learn, by deliberate self organization, to solve the environmental problems we face?

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