

On the Problems in and the Possibilities for Mapping International Chaos

Dylan Kissane
School of International Studies
University of South Australia

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Whether they consist of hastily scribbled squiggles on the back of an envelope, heavily contoured representations of local topography or high-tech handheld GPS depictions of highway systems maps are an essential part of everyday life. Maps serve an essential purpose by breaking down a complex three-dimensional world to a simpler, two-dimensional representation of that world's most significant features. Mapping is inherently a subjective and exclusionary practice as the cartographer decides which elements of the world are significant enough to be included, which can safely be ignored and what elements of the landscape are most central to the planar representation.¹ In a similar way, when an international relations theorist describes a new theory it is necessary to define the elements which are essential to understanding the complexities of an international political system, explain why other elements have been excluded and justify why those decisions were made. The subjective nature of theorising international affairs and the necessary exclusionary practices in which the theorist engages mean that the arguments supporting a new theory of international relations must be rather stronger than the arguments behind the scribbled directions one might offer a friend.

This paper considers the inclusive and exclusive decisions which have been made – and which remain to be made – in the pursuit of a theory of international relations founded on the assumption of a complexly interdependent, or chaotic, international political system and is presented in three parts. Part One reviews recent research in the discipline suggesting that the nature of the international system may be chaotic instead of a much more widely assumed anarchy. Part Two considers one potential drawback to this new theoretical direction – the need to include superficially inconsequential actors and interactions in a chaotic theory of international politics – in sharper focus. In a concise but detailed assessment of what has been termed the “problem of interdependence”, this part outlines precisely why this presents a quandary for chaoticians in the discipline of international relations.² In Part Three, however, this paper argues that it is possible to overcome the ‘problem of interdependence’ by first analysing and then adopting techniques from natural sciences that have already encountered and adapted their approaches to integrate chaos. Specifically drawing on meteorology and theoretical physics, this part of the paper suggests two routes by which international relations can theorise a chaotic international system. The paper concludes with the suggestion that a chaotic theory of international relations is potentially one step closer to emerging.

¹ Anne-Marie Slaughter, Andrew Tulumello and Stepan Wood. 1998. ‘International Law and International Relations Theory: A New Generation of Interdisciplinary Scholarship.’ *The American Journal of International Law* 92(3): 367-397, p.369.

² Dylan Kissane. 2007a. ‘A Chaotic Theory of International Relations? The Possibility for Theoretical Revolution in International Politics.’ *Revistă de științe politice editată* 2: 85-103, pp.99-100.

From Anarchy to Interdependence to Chaos

Assumptions about the fundamental nature of a system influence greatly the way that theorists and analysts interpret that system.³ Any assumptions made about the nature of the system effect the expectations that theorists have for actors within the system, the motivations for choice they apply to international actors and even who or what can be considered 'actors' in international politics at all. While theorists are in no way forced to assume a certain systemic structure or fundamental nature of the international system, the reality is that there are significant similarities across the discipline of international relations.⁴ Broadly put, the two most significant notions as to the underlying nature of the international system across the history of the discipline can be expressed as 'anarchy' and 'interdependence'. More recently, however, a third assumption about the nature of the system, 'chaos', has begun to emerge in the literature with its own implications for international relations theory. This part of the paper offers a narrative which traces the evolution within the discipline from the assumption of systemic anarchy to interdependence and chaos.

Despite challengers, the assumption that the international system is anarchic is an almost discipline-wide conjecture in international relations theory. The canonical works of international politics all have impressed upon the student of international affairs the centrality of the notion of an anarchic system and, thus, the notion has a history that spans not decades but millennia. Thucydides' classic *History of the Peloponnesian War*, for example, includes the celebrated Melian Dialogue where the realities of power in a world without an international mediator are made brutally clear to the citizens of Melos by Athenian envoys.⁵ The anarchic nature of world affairs is clearly expounded by the Athenians when they argue, "for we both alike know that in discussions of human affairs the question of justice only enters where there is an equal power to enforce it, and that the powerful exact what they can, and the weak grant what they must".⁶ The notion of anarchy would be later found in the works of Machiavelli and Thomas Hobbes, the latter's depiction of the "state of nature" being analogous to the depiction of anarchy in the realist international relations theory that would follow.⁷ Twentieth-century scholars such as EH Carr, Hans Morgenthau and John Mearsheimer continued to assert that the international political system was anarchic and their respective major works, *The Twenty Years Crisis, Politics among Nations* and *The Tragedy of Great Power Politics* all maintained anarchy as a founding assumption for the theories they developed.⁸ Finally, the neorealism spawned by the research of Kenneth Waltz and typified in his 1979 book, *Theory of International Politics*, saw the notion of an anarchic system promoted within a rigorous and claimed scientific approach to international relations, an approach that has gone on to be perhaps the most influential in the discipline's history.⁹

³ Henry Lane, Joseph DiStefano and Martha Maznevski (eds.). 2000. *International Management Behaviour: Text, Reading and Cases*. Boston: Blackwell Publishing, p.21.

⁴ Robert Powell argues that the assumption of anarchy is the same amongst realists and liberals and they debate not the reality of anarchy but its meaning and implications for world politics. See Robert Powell. 1994. 'Anarchy in International Relations Theory: The Neorealist-Neoliberal Debate.' *International Organization* 48(2): 313-344, p.314.

⁵ Thucydides. 1972. *History of the Peloponnesian War*. Harmondsworth: Penguin.

⁶ Thucydides. 1972, p.169.

⁷ Niccoló Machiavelli. 2005. *The Prince*. Oxford: Oxford University Press; Thomas Hobbes. 2004. *Leviathan*. Whitefish, MT: Kessinger Publishing.

⁸ EH Carr. 2001. *The Twenty Years Crisis 1919-1939: An Introduction to International Relations*. New York: Palgrave; Hans Morgenthau. 1993. *Politics among Nations: The Struggle for Power and Peace*. 6th edition. New York: Alfred A Knopf; John Mearsheimer. 2001. *The Tragedy of Great Power Politics*. New York: Norton.

⁹ Kenneth Waltz. 1979. *Theory of International Politics*. Reading: Addison-Wesley.

By the 1970s, however, a new assumption about the nature of the international system began to emerge in the theoretical literature. American scholars Robert Keohane and Joseph Nye opened the debate with their 1977 volume, *Power and Interdependence*, which offered an argument in favour of greater consideration of the effects of pan-system interdependence in international politics.¹⁰ This new approach, which in some ways culminated in Helen Milner's 1991 critique, 'The Assumption of Anarchy in International Relations Theory', did not so much suggest an end to the discipline's foundation on anarchy but rather highlighted the effects of interdependence, effects that would be felt with greater force as the Cold War gave way to a globalised world.¹¹ This new scholarship focussed on the effects of international interactions on both international and domestic spheres and rejected the artificial barrier between the anarchic international realm and hierarchical domestic politics. The common implication by anarchy-focused realists that the international world is separate from domestic politicking under constructed hierarchies was questioned and interdependence theorists like Milner who concluded that, whatever the import of anarchy, interdependence is at least as important and perhaps even more important for the theorists who seeks to understand and describe international political interactions.¹²

If the notion of an interdependent international system recognised the significant effects of interaction between states, groups and individuals on the wider system then the idea that the international political system is complexly interdependent and sensitively dependent on initial conditions, or chaotic, took the theoretical implications of international interdependence a step further again. Though yet to offer a complete alternative theoretical approach to anarchy-based realism, liberalism and even constructivism, proponents of an approach in which chaos is a central feature are clear in rejecting the anarchic system as a foundational assumption, something that liberalists, as argued above, did not do.¹³ The assumption of chaos emerged from the same sort of disillusion with realist explanations for international events, particularly in situations where realism seemed to fail. The fall of the Berlin Wall, the end of the Cold War and the emergence of the European Union as an actor in global affairs were all happenings that either went unpredicted by realists or could not be explained through resort to traditional realist doctrine.¹⁴ In seeking to reform the theory – something that many realists have attempted themselves in recent years – the fundamental realist assumption of systemic anarchy was challenged and it was theorised that this could and should be replaced with a foundation of chaos.¹⁵

¹⁰ Robert Keohane and Joseph Nye. 2000. *Power and Interdependence*. 3rd edition. New York: Longman.

¹¹ Helen Milner. 1991. 'The Assumption of Anarchy in International Relations Theory: A Critique.' *Review of International Studies* 17(1): 67-85.

¹² Brian Schmidt. 2006. 'On the History and Historiography of International Relations.' In *Handbook of International Relations*, edited by W Carlsnaes, T Risse and B Simmons. London: SAGE, pp.3-22.

¹³ The current limitations of research in chaotic international relations are recognised by those researching in the field. See Dylan Kissane. 2006. 'The Balkan Bullet with Butterfly Wings.' *CEU Journal of Political Science* 1(4): 85-106, p.100.

¹⁴ Jack Snyder considers such failures of realism in a 2004 article in *Foreign Policy* where he argues that "post-9/11 developments seem to undercut one of realism's core concepts: the balance of power...Realists are scrambling to find a way to fill this hole in the center of their theory". He also argues that, the "United States' strained relations with Europe offer ambiguous evidence: French and German opposition to recent U.S. policies could be seen as classic balancing, but they do not resist U.S. dominance militarily. Instead, these states have tried to undermine U.S. moral legitimacy and constrain the superpower in a web of multilateral institutions and treaty regimes—not what standard realist theory predicts" and "Realists failed to predict the end of the Cold War, for example. Even after it happened, they tended to assume that the new system would become multipolar...". See Jack Snyder. 2004. 'One World, Rival Theories.' *Foreign Policy* 145: 52-62, p.56; p.61.

¹⁵ For realists adjusting their own anarchy-based paradigm see Jeffrey Legro and Andrew Moravcsik. 1999. 'Is Anybody Still a Realist?' *International Security* 24(2): 5-55. For chaos based approaches see Kissane. 2006; Kissane. 2007a; Dylan Kissane. 2007b. 'Offensive Realism and Central & Eastern Europe after the Cold War.' *CEU Journal of Political Science* 2(4): forthcoming.

Hence, from Thucydidian anarchy, through Keohane and Nye's interdependence to new notions of a chaotic international dynamics, the conception of the international system amongst theorists has evolved and, with this evolution, new theories have emerged. Yet problems exist for theories based around the notion of a chaotic dynamic in international affairs. A relatively new approach to international relations – indeed, a chaotic approach is still in its embryonic stages – the problems that exist have been mentioned in works such as 'A Chaotic Theory of International Relations?' and 'Political Science at the Edge of Chaos?' but have yet to be considered in great detail.¹⁶ In the following section of this paper one of those problems, the so-called "problem of interdependence", will be outlined and its significance as a roadblock to the development of a chaotic theory of international relations explored.¹⁷

A Chaotic System and the Problem of Interdependence

Before outlining the particular problem of interdependence in a chaotic theory of international relations it is necessary to outline just what a chaotic system is and what the assumption of chaos means for theorising international affairs. Chaos and chaotic dynamics are terms more often associated with physical systems in meteorology and biology and fundamental work in mathematics and physics than international political relations.¹⁸ The fundamental features of chaos, however, are well known to even lay observers of political affairs. Indeed, the famed chaotic analogy termed the 'butterfly effect' – wherein the beating of butterfly wings in China cause a hurricane in the United States – is in line with folkloric reflections on the potential impact of small events on a much larger scale.¹⁹ Consider the well-known proverb:

For want of a nail, the shoe was lost;
For want of a shoe, the horse was lost;
For want of a horse, the rider was lost;
For want of a rider, the battle was lost;
For want of a battle, the kingdom was lost!²⁰

Cutting through the verse we conclude that the lack of a single horseshoe nail led to loss of an entire kingdom and thus is demonstrated the butterfly effect that would be coined by meteorologist Edward Lorenz in a 1979 speech.²¹ In chaotic systems small elements such as horseshoe nails and butterfly wings can have a disproportionate impact on the wider system and, further, under chaos it becomes clear that such small events cannot be measured precisely enough to

¹⁶ Kissane. 2007a; Shu-Yun Ma. 2007. 'Political Science at the Edge of Chaos? The Paradigmatic Implications of Historical Institutionalism.' *International Political Science Review* 28(1): 57-78.

¹⁷ The problem of interdependence is outlined in Kissane. 2007a, pp.99-100.

¹⁸ The significance of chaos and chaotic dynamics in these fields is broad but general surveys exist which offer a broad review of the impact on the field. The edited volume *The Impact of Chaos on Science and Society* (Grebogi and Yorke, 1997) is a particularly good reference in this regard. From that volume and on chaos in meteorology see Antonio Speranza. 1997. 'The impact of chaos on meteorology.' In *The Impact of Chaos on Science and Society*, edited by C Grebogi and J Yorke. Tokyo: United Nations University Press, pp.232-242. On chaos and biology see Bruce Kendall, WM Schaffer, CW Tidd and Lars Olsen. 1997. 'The impact of chaos on biology: Promising directions for research.' In *The Impact of Chaos on Science and Society*, edited by C Grebogi and J Yorke. Tokyo: United Nations University Press, pp.190-218. On mathematics and chaos see David Ruelle. 1997. 'The impact of chaos on mathematics.' In *The Impact of Chaos on Science and Society*, edited by C Grebogi and J Yorke. Tokyo: United Nations University Press, pp.97-109. On physics and chaos see Mitchell Feigenbaum. 1997. 'The impact of chaos on physics.' In *The Impact of Chaos on Science and Society*, edited by C Grebogi and J Yorke. Tokyo: United Nations University, pp.127-132.

¹⁹ Michelle Young. 2002. 'Chaos All Around: Butterflies, Demons and the Weather.' *Harvard Science Review* (Winter 2002): 29-32.

²⁰ James Gleick. 1987. *Chaos: Making a New Science*. New York: Palgrave, 23. The original verse is variously attributed to either John Gower or Benjamin Franklin.

²¹ Edward Lorenz. 1979. *Predictability: Does the Flap of a Butterfly's Wings in Brazil Set Off a Tornado in Texas?* Address to the American Association for the Advancement of Science, Washington DC, United States, 29 December 1979.

account for them all. Prediction, at least in the long term, becomes impossible and attempts to forecast future realities become probabilistic at best and misguided at worst.²²

In terms of political systems there has been some research that suggests that international politics may experience chaotic processes. Diana Richards in her 1993 paper, 'A Chaotic Model of Power Concentration in the International System', offered the first detailed assessment of and suggestion that chaotic dynamics may exist in international political interactions.²³ Modelling data on international seapower from the work of George Modelski and William Thompson she was able to conclude that "from the analysis of the empirical data on power evolution indicated...the evolution of power is a chaotic process".²⁴ More recently research on the beginning and end of conflicts in the European theatre have suggested that chaotic dynamics may be at work. One article argues that the events that led to the outbreak of war in the Balkans in 1914 are best described through reference to individual and local level events under chaos than inter-state tensions and military competition under anarchy.²⁵ Another argues that the peace that followed the end of the Cold War – largely unpredicted by theoretical realists and their explanations of interstate relations under anarchy – can be explained with reference to the small, localised and domestic events that the assumption of a chaotic system forces the analyst to consider.²⁶ At its most basic level, the assumption of a chaotic system forces the scholar to consider events at the domestic and individual levels of analysis and their potential impact on the wider global system. In doing so, however, a major drawback to the chaotic approach emerges: the so-called problem of interdependence.

The problem of interdependence was highlighted first in a 2006 conference paper, *Beyond Anarchy and Interdependence*, and was considered in greater detail in the 2007 article, 'A Chaotic Theory of International Relations?'²⁷ As argued in that article, the problem of interdependence emerges when it becomes impossible to exclude any local or individual level cause from the analysis of an chaotic international system as each and every element of the system has the potential to play the role of 'the butterfly' and effect significant change across the system.²⁸ In 'A Chaotic Theory of International Relations?' the problem of interdependence is explained thus:

It is surely impossible to account for the actions of every human on the planet and the implications of all of their actions on the wider system, yet a chaotic system, by definition, is one in which such small permutations at the individual level can affect the entire system and all other actors within it... the theorist has to make a choice as to which actors or level of interdependence they will restrict their analysis to...[However] while it is necessary for the sake of a comprehensible theory that the number and nature of the actors assessed is limited, it is also antithetical to the chaotic approach to exclude actors, which may have a significant effect on events in the system, so arbitrarily.²⁹

²² Edward Lorenz. 1979. 'On the Prevalence of Aperiodicity in Simple Systems.' In *Global Analysis*, edited by J Marsden and M Gmela. New York: Springer-Verlag, pp.53-75, p.56.

²³ Diana Richards. 1993. 'A Chaotic Model of Power Concentration in the International System.' *International Studies Quarterly* 37(1): 55-72.

²⁴ Richards. 1993, p.66.

²⁵ Kissane. 2006.

²⁶ Kissane. 2007b.

²⁷ Dylan Kissane. 2006. *Beyond Anarchy and Interdependence: New Thinking about an Old System*. Paper presented at 'Order in Disorder in a Changing World', American Graduate School of International Relations and Diplomacy, Paris, France, 19-20 June 2006.

²⁸ Kissane. 2006, pp.20-22.

²⁹ Kissane. 2007, pp.99-100.

The problems facing the scholar who wants to build a theory on a foundation of chaos are essentially the same ones faced by the cartographer who draws a new map: what must be included and what can be safely excluded so as the map is of practical use to the reader.

The cartographer who wishes to map international politics chooses a manner of projection and identifies geographic features, political boundaries and lines of longitude and latitude which he adds to his representation of the political world.³⁰ The person who seeks to describe to a friend a cross-city route would mention major landmarks, suggested streets and any false turn that is likely to lead his friend astray. In either case the map-maker chooses to exclude largely irrelevant elements of the landscape in favour of the essential items by which the landscape can be determined. Thus, even a city-scale map would likely exclude the potholes on Main Street and a depiction of political boundaries on paper is likely to discard all notions of elevation save in the knowledge that a boundary is a boundary, whether at 2000 metres or sea level. Yet any driver will be aware that potholes are potentially very dangerous obstacles to a vehicle and, similarly, any customs agent is aware of the significance of the geography surrounding a nation's border; why, then, can such features be ignored by the mapmaker? Simply put, the reason is that the primary explanation the cartographer seeks in each case is not overly affected by potholes and altitude but rather the features highlighted.³¹ When mapping the international system, international relations theorists have chosen to highlight some elements and marginalise others.

The starkest examples lie in strict realist theory. The most significant elements in a realist's anarchic system are nation-states.³² Twentieth century realism, perhaps even all realist thought post-Westphalia, focuses on the state as the most important actors in international affairs.³³ They are the only actors with a legitimate recourse to force, they exist as sovereign equals in the international political system and any institution that has any legal or statutory power over states maintains such power only with the express consent of the states.³⁴ Realists do not refuse to recognise nor suggest that there are other international actors. Indeed, international institutions, corporations and terrorist groups are examples of non-state actors that realists have considered in their analysis of international relations, particularly in the post-Cold War period.³⁵ Yet consideration of these non-state actors does not mean that they are afforded the same significance as states actors: they are not.³⁶ Instead, a realist theoretical map begins and often ends with an outline of

³⁰ Tangentially, maps as political objects are considered in Arthur Klinghoffer. 2006. *The Power of Projections: How Maps Reflect Global Politics and History*. Westport, CT: Greenwood.

³¹ As Elaine Hallisey argues, "The goal of the cartographer [is] to achieve as "true" a depiction of reality as possible while maintaining objectivity." See Elaine Hallisey. 2005. 'Cartographic Visualization: An Assessment and Epistemological Review.' *The Professional Geographer* 57(3): 350-364, p.352.

³² As Kenneth Waltz argues, « States are the units whose interactions form the structure of international political systems. They will long remain so." See Waltz. 1979, p.95.

³³ Michael Mastanduno agrees, arguing that "the most important actors in international politics are "territorially organised entities" – city-states in antiquity, and nation-states in the contemporary era." See Michael Mastanduno. 2001. 'A realist view: three images of the coming world order.' In *International Order and the Future of World Politics*, edited by T Paul and J Hall. Cambridge: Cambridge University Press, pp.19-40, p.21.

³⁴ Indeed, states are often reluctant to cede their sovereignty to international institutions. See, for example,

³⁵ Realists don't deny their importance, only their primacy. See, for example, John Mearsheimer. 1994. 'The False Promise of International Institutions.' *International Security* 19(3): 5-49; Benjamin Frankel. 1996. *Realism: Restatements and Renewal*. London: Routledge, pp.xiv-xv; John Mearsheimer and Stephen Walt. 2002. *Can Saddam be Contained? History Says Yes*. Balfer Center for Science and International Affairs Paper, 12 November 2002.

³⁶ Harvard Post-Doctoral Fellow Skyler Cranmer makes this point in noting that, "It is not difficult to expand realism in the context of terrorism to include the terrorist group (a non-state actor) into the analysis. Rather, the serious weakness of realism in this context

state actors and the attributes of those states under anarchy with considerations of non-state actors an afterthought and often a very limited one.

Realists, though, have come to see their simplified theoretical maps of the international system called into question.³⁷ Any simplified representation of a system will, like any map, not include the small elements of the system that are considered unimportant. Yet the realist assumption of anarchy and the subsequent focus on the most significant actors under anarchy, the nation-states, has meant that the realists have failed to predict and even explain major events and trends in international politics. Events such as the end of the Cold War and the peaceful integration of states that have led to the emergence of the European Union are not small speed-bumps or potholes on the map of international affairs but major turning points and, according to some, system changing events.³⁸ The failure of anarchy-based realism to predict such major events in the international system suggest that the theoretical map from which realists work is flawed and, thus, a move by theorists to redraw realist theory to better explain international affairs. Jeffrey Legro and Andrew Moravcsik considered these changes in realist theory in their article, 'Is Anybody Still a Realist?', noting that the attempts by realists to broaden their theory and encompass more and more elements of the system in their theoretical maps have, instead, diluted the theory.³⁹ It should not be surprising, then, that some theorists have investigated the possibilities for greater theoretical revolution questioning not only the elements that realists include in their theories but also the underlying assumptions about the system in which international politics exists.

Yet like the realists faced with the Cold War and the emergence of the European Union as challenges to their prevailing world view of a system of states, theorists who turn to a chaotic system face similar problems in deciding what to include and exclude.⁴⁰ This problem is further compounded by an election to argue that the international system is chaotic with the implication that all elements of the system are significant and, thus, none can be excluded from analysis. But like a map that includes every pothole, every street sign and every white line on the road surface, a theory which includes every individual element in the international political landscape is of little utility for finding your way. Solving the problem of interdependence requires the international chaos theorist to either choose what to include and exclude as elements in their theories and it is the argument of this paper that the model best able to solve this problem is one that is common to cartographers and back-of-the-envelope map makers worldwide: an ad-hoc choice of elements adjusted to suit situational circumstances.

Overcoming the Problem of Interdependence

Chaotic systems are not unique to international politics. Indeed, chaotic systems have been recognised in natural systems in biology, meteorology, population dynamics and mathematics.⁴¹ The same problems of interdependence that

is that a terrorist group cannot (reasonably) be assumed to be attempting to balance a state; nor can one really conceive of a security dilemma between an ENT [ethno-national terrorist] group and a state." See Skyler Cranmer. 2005. *Terrorism Second Pass*. [19 December 2007] <http://tinyurl.com/2p2zhd>.

³⁷ See, for example, the critical essays in Robert Keohane (ed.). 1986. *Neorealism and Its Critics*. New York: Columbia Press.

³⁸ On arguments as to why these were "fundamental transformations" see Rey Koslowski and Friedrich Kratochwil. 1994. 'Understanding change in international politics: the Soviet empire's demise and the international system.' *International Organization* 48(2): 215-247, p.215.

³⁹ Jeffrey Legro and Andrew Moravcsik. 1999. 'Is Anybody Still a Realist?' *International Security* 24(2) 5-55.

⁴⁰ Kissane. 2007, p.99.

⁴¹ Grebogi and Yorke. 1997.

a chaotic theory of international relations must overcome have already been considered and, in some case, overcome by these other disciplines and by learning from them it is possible, then, to seek an analogous solution to the problem being faced in international relations. However, it is in meteorology and climate research that offers perhaps the best outline of both the solution to the problem of interdependence and also what expectations we should have for a chaotic theory of international relations. While it is obvious that any new theory of international affairs would be expected to be superior to the ones it is offered in replacement of, what is less obvious is that a this new theory of international relations implies the impossibility of accurate long-term prediction of events in a chaotic political system. However, as the example of meteorology suggests, this should not be seen as a drawback but rather an evolution in the nature of international relations theory itself.

According to James Gleick,

Now that science is looking, chaos seems to be everywhere. A rising column of cigarette smoke breaks into wild swirls. A flag snaps back and forth in the wind. A dripping faucet goes from a steady pattern to a random one. Chaos appears in the behaviour of the weather, the behaviour of an airplane in flight, the behaviour of cars clustering on an expressway, the behaviour of oil flowing in underground pipes.⁴²

Chaos and chaotic systems exist across natural systems and increasing numbers of natural scientists have turned to chaos theories for answers to complex questions. Whether in aerospace and aeronautical physics, biology and the study of population dynamics in nature, mathematics and multidimensional space, chaotic dynamics have been identified and natural scientists have increasingly turned to chaotic explanations in proposing solutions to scientific questions.⁴³ Since Edward Lorenz first identified chaotic dynamics in weather systems the number of papers published on chaos annually has exploded to the point where the chaotic approach is able to support a number of scientific journals and where chaoticians, as they are known, now even “ally themselves first with chaos and only second with their nominal speciality”.⁴⁴ The impact of chaos on the natural scientists has been significant, indeed, though it is in meteorology, the discipline where chaos was first identified, that has experienced one of the most fundamental changes as a result of the recognition of the impact that chaotic systems have, both on the system and the theorists who study it.

The impact of recognising that weather and climatic systems were chaotic was immense. In the post-World War Two period it was widely thought that predicting weather patterns was simply a matter of measuring the significant variables, understanding how these variables interacted and identifying the scientific laws that would enable long-term weather prediction to be as simple as plugging numbers into a mathematical equation.⁴⁵ Lorenz’s work at the Massachusetts Institute of Technology in the 1960s, however, would change not only the expectations of meteorologists as to what their science could predict but also the approach to the study of the weather as a system. Lorenz’s conjecture, based on his research at MIT, led him to conclude that the weather systems he was studying were

⁴² Gleick. 1987, p.5.

⁴³ See examples in JM Ottino. 1989. *The Kinematics of Mixing: Stretching, Chaos and Transport*. Cambridge: Cambridge University Press, p.x; R Engbert and FR Drepper. 1994. ‘Chance and chaos in population biology: Models of recurrent epidemics and food chain dynamics.’ *Chaos, Solitons and Fractals* 4(7): 1147-1169;

⁴⁴ Gleick. 1987, p.5.

⁴⁵ Gleick. 1987, pp.18-21.

infinitely more complex than he and others had previously imagined.⁴⁶ Indeed, so much more complex and unpredictable were climatic systems that Lorenz would conclude “that long-range weather forecasting must be doomed” and that, more broadly, “any physical system that behaved nonperiodically would be unpredictable” in the long term.⁴⁷ The assumption of a chaotic climatic system rather than a complicated (but still linear) climatic system fundamentally changed the way that weather and climate are studied and the implications of Lorenz’s research and the research that followed are incredibly important.

The major implications can be divided into two groups: implications for expectations and implications for methodology. In terms of expectations Lorenz’s basic realisation as to the predictability of the system is central. Meteorologists no longer offer concrete long-term predictions for weather and climate understanding, as they do, that such predictions are impossible.⁴⁸ Meteorologists also no longer expect that their knowledge of the system will grow to the point where they will one day be able to predict the system. The optimism expressed by meteorologists in the 1950’s and 1960’s as to the eventual “mastery” of the weather has disappeared as the realities of a chaotic system become both understood and accepted.⁴⁹ The implications for methodology are equally significant. With scientific prediction based on a linear understanding of meteorology obviously no longer feasible for the discipline, meteorologists moved to modelling future outcomes and began to offer multiple future possibilities wherein each model lent greater weight to different elements of the climatic system. Hence, the Intergovernmental Panel on Climate Change (IPCC), the United Nations’ body charged with investigating the phenomena related to climate change, presented 40 different scenarios on future climate trends, all of which demand a slightly or even significantly different reaction by political actors worldwide.⁵⁰ The methodology of the meteorologists has, as Bjørn Lomborg noted, “the modellers have explicitly abandoned the idea of predicting the future and instead talk about projections and possible futures”.⁵¹ In analysing a chaotic system meteorologists and climatologists have recognised that predicative certainty and the weight attached to different elements at different times can no longer be considered as simply constants in a mathematical equation.⁵²

The experience of the meteorologists and climatologists in first facing and then adapting to the realities of a chaotic system are analogous to what the discipline of international relations faces in light of theorists who call for recognition of the international political system as a chaotic system of its own. International relations theorists, like meteorologists, once imagined (and some even continue to imagine) that it will one day be possible to predict the future of political

⁴⁶ Gleick. 1987, p.21.

⁴⁷ Gleick. 1987, pp.17-18.

⁴⁸ As reported in 2007, “In general, meteorologists do not consider day-to-day forecasts for more than a week or 10 days ahead to be possible, and the best forecasts are for five days or less into the future. Instead of trying to predict the day-to-day weather for more than a week or 10 days ahead, forecasters produce generalized outlooks giving the odds of temperatures and precipitation being average, above average or below average for days, months, or entire seasons.” See USA Today. 2007. *Long-term weather outlooks*. [20 December 2007] <http://tinyurl.com/3anzl2>.

⁴⁹ Gleick. 1987, Chapter 1.

⁵⁰ The IPCC acknowledge the benefits of producing dozens of potential futures in their SRES scenarios arguing that, “One advantage of a multi-model approach is that the resultant 40 SRES scenarios together encompass the current range of uncertainties of future GHG emissions arising from different characteristics of these models, in addition to the current knowledge of and uncertainties that arise from scenario driving forces such as demographic, social and economic, and broad technological developments that drive the models, as described in the storylines.” See IPCC. 2000. *Emissions Scenarios: Summary for Policymakers*. [20 December 2007] <http://tinyurl.com/3db666>, p.3.

⁵¹ Bjørn Lomborg. 2001. *The Skeptical Environmentalist: Measuring the Real State of the World*. Cambridge: Cambridge University Press, p.280.

⁵² IPCC. 2000, p.3.

systems if only enough to the underlying laws are understood.⁵³ Also like meteorologists, international relations scholars – and in particular realists – favour simple, linear relationships between elements of the system. This leads realists to offer articles which include “if X then Y” statements and write of future outcomes with a confidence that is, at times, severely misplaced. Like meteorologists began to understand, there is a growing recognition that long-term predictions as to the future of the international system is most likely to be flawed, with standout examples relating to the robustness of the Soviet Union and the likelihood of European integration being standout examples of such predictions failing to come close to the reality of the system.⁵⁴ Finally, like meteorology, international relations finds itself with an option to consider an alternate underlying order to the political system – chaos – in place of the widely-assumed anarchy of today’s most popular theories. Yet unlike meteorology which had to find its way through chaos without any guidance, international relations theorists can learn from the experiences of those who have already adjusted their theories and methodology to a world of chaos. In essence, international relations can learn from meteorology and can find analogous solutions to the problem of interdependence that a chaotic theory of international relations presents.

Theories of international relations that assume a chaotic system should, like meteorologists, change their expectations of their theories. The notion of long-term and even medium-term prediction of the international system should be rejected in favour of an effort towards explaining the events that have and are occurring in international politics. As in existing assessments reliant on a chaotic foundation in international relations, there are significant opportunities to revisit events explained poorly by existing theories of international politics and to identify new explanations for events that are thought to be already adequately explained. More significantly in relation to the problem of interdependence, though, the multiple modelling of future weather and climatic events offered by meteorologists sets an example for how international relations theorists might approach the multiple and simultaneous interactions between large and small elements that define the chaotic international system. Like climate modellers who offer multiple possible futures – up to 40 in the case of the IPCC report – the international theorist can offer various futures for the system based on different elements interacting in different ways in each case.

The implications for theory, then, are clear: a theorist who embraces the notion of a chaotic system must reject the possibility of medium-term and long-term prediction while adopting methodologies which allow for the discussion of multiple future possibilities instead of the linear, ‘if X then Y’ formulations common to realism. The problem of interdependence can be mitigated by weighing elements of the international system under chaos differently in multiple models of international relations. For example, the theorist might construct a model of international affairs where state interests are the most important element in the system, another where local level factors are very significant, another where international institutions impact significantly on the elements of the system and one where small and independent groups are the most significant players. Such a methodology demands that the small but potentially system-changing elements common to chaotic systems are both identified and considered by the theorist of international affairs and only a multi-dimensional, multi-possibility methodology will allow for the problem of interdependence to be overcome.

⁵³ See discussion in William Callahan. 2004. ‘Nationalising International Theory: Race, Class and the English School.’ *Global Society* 18(4): 305-323, p.305; pp.308-309.

⁵⁴ Kissane. 2007b.

Conclusion: Mapping the Chaotic International System

Developing a theory of international politics demands that, like a map maker, the theorist decide which elements are important enough to include and which can be safely excluded without affecting the utility of the end product. Mapping a theory of international political chaos, however, complicates such choices as it is not at all clear what calculus can be used to determine which elements should be included and what weight is to be afforded to them when they are. This problem of interdependence under political chaos is similar to the problems natural scientists faced when adapting their inadequate linear models to what were found to be chaotic systems. Indeed, the example and experience of meteorologists and climatologists in the 1950s and 1960s are similar to the experiences of international relations theorists today who seek to consider the international system as chaotic. Drawing on the experiences of those meteorologists, a potential solution to the problem of interdependence is found whereby the chaos theorist in international relations to the problem of interdependence. This solution – a change in the expectations of the theorist as to what their theories can and should be able to accomplish as well as a change in the methodology by which assessment and predictions are made – allows for the analysis of a chaotic international system without necessarily excluding any particular element of that system nor always including the same elements in the assessment of an international situation. The resultant map of the international system both embraces the complexity of politics under chaos as well as offering an explanation of that system that the analyst can use to find their way in the world and that, after all, is the goal of every cartographer of the international system.

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