from the Bustard

Bouncy castles or potatoes? What we are learning about resilience, efficiency, and risk management

Hooray. People are talking about resilience again. This happens every ten years or so when a scary thing happens like the financial crash or 9/11 and we get worried about how our lives, livelihoods, society and civilisation will stand up to the disruption. Then when things go back to normal they forget about it. This post takes a look at resilience, its position as a counterpoint to efficiency, its different forms, and how we can make our lives more resilient and, thereby, better.

Warnings: I don't use hyperlinks. I think they distract the reader, interrupt the flow of thought, thereby impairing comprehension. It's so easy to find things on the internet these days, that they are practically superfluous anyway.

There is a trade-off between efficiency and resilience

There used to be an independent pharmacy in the small, northern English town of Kirkby Lonsdale where I grew up. It had beautiful wooden, Victorian shelving with elegant glass jars of remedies and potions. The pharmacist knew customers and their ailments and took some of the pressure off the doctor's surgery. Then the shop was sold to Boots and everything was swept away and in came the dull, faux-clinic standard blue and white make-over. It upset me because something local, original and genuine was disrespected and trashed by a corporate machine seeking efficiency through uniformity.

About thirty years ago a mathematician friend had been studying queueing and explained to me that if you remove apparently underused hospital beds or counters at bank branches, the efficiency gain can backfire and lead to exponentially growing queues at certain times.

During my accounting studies I learnt about just-in-time inventory. It always seemed very pushy to me and I wondered what happened if something went wrong in the supply chain and you ran out of goods.

At the time of 9/11 and eight or nine years later during the financial crash, I thought a lot about the fragility of our society – both the economic structures and the social contract. How easy it is for the house of cards to collapse and people to turn nasty and on each other, even as crisis brings the best out of some people. As a result of that a friend and I set up an organic market garden – if the shit hits the fan, the most fundamental need is to be able to produce food for ourselves.

All these thoughts led me to reflect on resilience and efficiency. I saw that in a system you often get a trade-off between the two. As you make a system more efficient, you lose resilience; if you want to make the system more resilient, you might have to pay for it by lowering efficiency. Not all gains in efficiency impair resilience, but many do.

Measuring efficiency and resilience

One reason we overlook resilience is that it is complicated.

Efficiency is an easy measure to understand. You compare the output of something with the input: output as a portion, fraction or percentage of input – it is similar to yield. However, we tend to overlook that efficiency is predicated on a fixed set of operating conditions. The efficiency of a motor, for example, is such-and-such *at a given operating temperature*. If the temperature gets too high or too low, the efficiency will drop off. The efficiency of a solar panel drops off if it gets too hot outside and the panel is not cooled by the flow of air underneath it. Mathematically, efficiency is x/y.

Resilience, however, is more complicated. Resilience is a statement about the performance or efficiency of a system under a range of operating conditions. Resilience considers how wide the range of operating conditions is under which the system can keep going, produce an acceptable amount of output. Take, for example, a regenerative-organic farmer whose soil can hold water better than a conventional farmer. The regenerative-organic farm will continue to perform in drought conditions, while the conventional farmer might have crop failure. While under ideal conditions the regenerative-organic farmer might enjoy a lower yield than the conventional farmer, under varying or difficult conditions the regenerative-organic farmer performs better.

Mathematically, resilience is about combinations of many standard deviations and dealing with probabilities and optimisations. It embraces uncertainties of the full range of operating conditions which might apply – blue moons, flying pigs and black swans – perhaps to the point that not even maths can help us.

Resilience and efficiency at the level of an economy

At times like now or the financial crash ten years ago, we see which systems can tolerate a wider or even extreme range of operating conditions and which cannot, giving us insight into their degree of resilience.

The trade-off is made at many levels. Consider the globalised economy. Globalisation is an application of the economic principle of comparative advantage or specialisation. Kenyans grow flowers better than people in Kent, so let the Kenyans send us carnations and the people of Kent can put bouncy castles on their farmland.

When things break down, though, the Kenyan flower growers don't have any source of income. Nor do the Squires of Chateau Gonflable. Kenyan flower growers had to trash their stock because they couldn't ship it to a locked down Europe. Months of income rotted away. Those farmers, who as well as growing a luxury export good or a cash crop, prudently kept aside some of their land for horticulture, can still produce food for themselves if the export market collapses.

So you might say: globalisation is bad news in a time of crisis because people specialise so much, they lose their ability to look after themselves. Globalisation can mean that supply lines are often

too long and dispersed to allow for effective, local redeployment of skills and resources in the event of a threat to the system. There's something in that as illustrated by the Kenyan florists.

But that doesn't mean bash the free market. Free markets *can* make the response to a crisis more effective: resources can be more nimbly redeployed; goods, services and skills can be shifted – digitally or physically to where they are needed. A friend told me that the Bengal famine of 1943 was exacerbated because stifling regulation stopped the flow of food to the area from areas unaffected by famine. Perhaps if the UK had not shut itself off from the EU's systems, they might have been better supplied with tests for Covid 19. Well running markets have their own resilience – one part of the system might fail, but other parts step in to compensate.

Resilience versus risk

Being resilient is a form of risk management – it makes you better at handling threats when they materialise. Another approach is to reduce the probabilities surrounding the risks you face and for which you want to be resilient. As in "prevention is better than cure".

It is dumb of people to take animals from the wild, put them in markets live with no hygiene controls. And then let those people meet other people who travel around the world carrying the bug. It is even more dumb to repeat it after pandemics like SARS have happened. Just because some poor people depend on wildlife trafficking does not excuse the recklessness of individuals, town councils, companies, governments in permitting such activity.[1] So, if we managed that risk by not permitting trade in wildlife, we would not need to implement such resilience measures. Hence a trade-off between preventative risk management and resilience. Still, preventative risk management measures can fail, so you might still need your resilience measures.

In some situations there is a curious blending of reducing risk and increasing resilience at the same time. Regenerative farming, for example, contributes to mitigating climate change by sequestering carbon in the soil and in perennial vegetation, so at least in some theoretical sense, reduces the risk of drought.[2] However, it also makes the land more resilient – more able to withstand drought because cover crops slow the drying of soils and healthier soils hold more water.

But I have started rather in the middle, by comparing resilience with efficiency and linking it with risk management. Back to today, and then some definitions.

Resilience and catastrophe

Catastrophe teaches us about resilience. So much so that we might think that resilience is the same as being able to handle catastrophic extremes.

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[1] To do so would mask the root of the problem, which is that poor people need access to good sources of food.
[2] If scaled up across all the world's agricultural land it would very definitely reduce the risk of drought by sequestering billions or even a trillion tonnes of CO_2 in our soils

Strictly, this is not true. Resilience is there all the time – reflecting our ability to operate normally under any fluctuation in operating conditions. As long as our systems work out and tolerate ordinary fluctuations in operating conditions, we don't know that we are being resilient because our resilience is not tested. But the fact that "the world" can carry on whether it rains or shines, whether inflation is zero or 10%, whether it's a good harvest or a relatively weak harvest, or whether the prime minister is ill or not, shows that we do have plenty of resilience. It's just that, because operations carry on unchanged, we don't notice its effect: the effect of resilience is to maintain normality. That is, resilience has no perceptible effect! The better it does, the less you notice it.

Things start to break down under catastrophe. This means that an intolerable number of people suffer unacceptably. It seems that we have a standard of what is an acceptable and what is an unacceptable level of disruption to people. And when that level of disruption is reached, that is the signal that our system is not managing, and then prompts thoughts that we are not resilient enough.
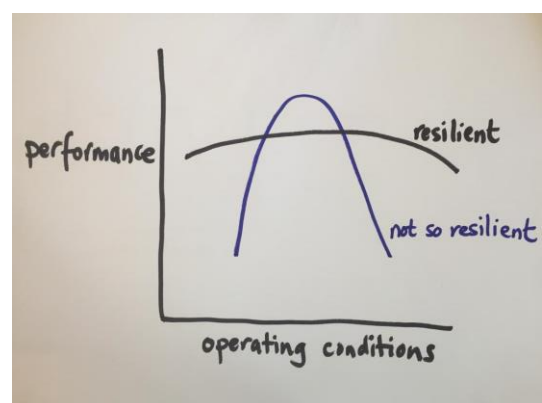
When we are in a catastrophe and feel disruption, we feel that we should have planned better and built resilience so that this disruption would not happen. The closer we are to the epicentre, or the better our empathy is, the more likely we are to feel that. To avoid disruption when catastrophe strikes, we need to be constantly building and investing in resilience during good times.

The syntax and logic of resilience

I think the syntax of resilience is: X is resilient to Y. X could be an object, a person, a living form, an organisation, a system, a country. A pretty wide range of things can be resilient. In fact, anything which can be threatened with being broken. Y is anything which could break X. It could be a disease, a predator, a temperamental flaw, a falling brick, a spy ... again very wide. Anything which can cause trouble to something.

The logic of resilience is that something is not resilient if it suffers unacceptable disruption when operating conditions move outside a certain range. This requires a definition of unacceptable, and specification of the range. In a rich country, unacceptable implies a narrower range than a poor country. The range is also expected to be wider.

The graph to the right plots performance under different operating conditions for a resilient and a not so resilient system.[3]

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[3] For simplicity, all operating conditions are squeezed together in one axis. Reality is not like that, so you would have a graph like this for each of the operating conditions which apply to the system. Some would impact the shape of the performance curve more than others.

In the next picture, the upper green line is an arbitrary minimum acceptable level of performance, adopted, say, for the not so resilient system. The lower green line is the minimal acceptable level of performance adopted for the resilient system. In the resilient system a somewhat "lower" level of performance in tolerated.

In the following graph, lines A and B show the range of operating conditions which are tolerable in the not so resilient system, and C and D show the range of operating conditions which are tolerable in the resilient system.
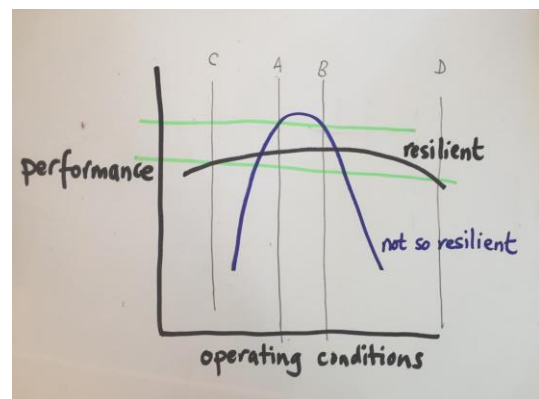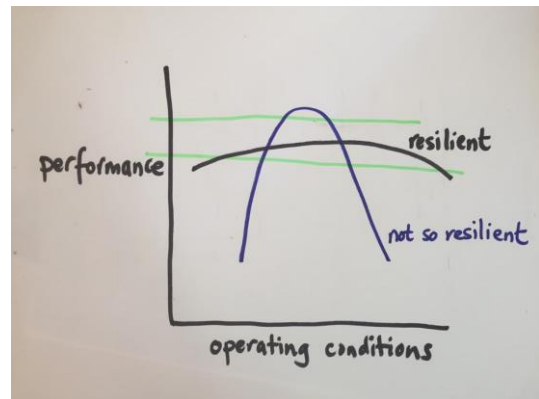

For clarity, the green lines which reflect the lowest acceptable level of performance of the system, are somewhat arbitrary, not usually a fundamental property of the system. They could be based on law (particulate emissions from an engine), on guidelines (number of days you stay in hospital after an operation), convention, fashion or culture. They are themselves the synthesis of a range of levels in the affected group of people – personal green lines are higher or lower than agreed on system-level green line. Some people happily tolerate worse performance than others – they might be more understanding, more forgiving, inured to it or have less acute senses.

Resilience measures are the things we do increase our resilience – either pro-active measures up-front in anticipation of a threat or reactive responses at the time a threat arises.

Eleven forms of resilience

I thought about ways in which resilience is achieved and came up with eleven. They might not be mutually exclusive. There are definitely more, depending on how you slice things up.

1. Fort Knox: If you make something strong enough, whatever hits it, won't make a dent. That's the thinking behind Fort Knox or sea wall defences built of many meters of solid concrete. It doesn't need to be as brutal as thick walls – it could be friction or wiggly lines – things that slow down threats, like upland trees making towns more resilient to flooding. Politically, I think it's the philosophy of the single-party state approach of China.
2. Pile 'em high: Hold inventory, hold regulatory capital. Many business efforts, such as just-in-time or gearing up a balance sheet, are a clear trade-off between efficiency and resilience. If you have lots of inventory, you can withstand supply failure for longer periods. If banks

3. Diversity: Avoiding dependency on any one thing or any one type of thing – whether a supplier, a technology, a customer, a friend, a provider, a crop – such dependency means that if one of those fails, you can still rely on others. If you grow monocultures or all your high streets look the same, you are more exposed to blight – keep it diverse and varied. This might extend to the kind of resilience implied where you hold stocks of pen and paper or print-outs of ledgers or old copies of *Viz* magazine, so if your internet connection blows up, you can carry on working and being entertained.
4. Jack of all Trades: Functional agility means you can switch from one market to another your existing market fails. An example is my friend in Transylvania who can build houses, keep sheep and make cheese, grow crops, play the violin and manufacture leather boots.
5. Side step: If you have physical mobility, you can move away from the threat. A house cannot. A person can. But a house with extendable stilts can, to avoid flood.
6. Nip in the bud: If you are alert and insightful and smart, and have swift flows of truthful information and matching analytical skills, you can be resilient by nipping threats in the bud before they become … pandemics. This could be like an immune system in a body or a pandemic avoidance plan of a country.
7. Atomisation: If your entity comprises lots of small disparate units, if one unit is harmed, the others can still function. This is a tactic used by some resistance organisations.
8. Living system: with fine-grained modularity, when one element fails you can quickly replace it with another, or another element takes over its role. Information flows and feedback loops allow for intelligent and agile responses; repairing means that elements can quickly be brought back into play. This is how a free market works or an ecosystem. It is resilient because any failing element gets replaced or substituted quickly enough to stop the whole system failing.
9. Insurance: where you purchase resilience from someone else.
10. Mental resilience: under mental resilience you don't let yourself get bothered by the disruption caused by adverse changes in operating conditions, through some form of Buddhist-like or Stoic-like mental state. You effectively redefine catastrophe so that when those things happen which others would call catastrophe, they don't cause you mental anguish, and
11. Normative resilience: this is a bit like ten, but it is to say that your definition of what is an acceptable disruption caused by changes in operating conditions is broader. If you lived in Haiti, every day beset by catastrophe, life a pattern of destruction and rebuilding, you keep going in conditions which, to a European, would be utterly bewildering and outside the boundary of "acceptable" (if it's not "acceptable", there's not much you can do about it.)

Resiliences might well be combined. Your emergency coffee store (type 2) might be held in several different pots (7), each with strong protection against night-owl housemates (1). And you might even hold a stock of maté (3) just in case.

Passive and active resilience

You can broadly break these approaches to resilience into two, perhaps three areas. The two are:

- Passive resilience
- Active resilience

In passive resilience, you have a low-intelligence system which is set up at the beginning and does not need a lot of maintenance. It is designed to withstand a certain range of operating conditions. Sea defence walls, very strong safes, high levels of capital and stock are in this category. Even these things need some maintenance and checking, from time to time, but not continual attention. You have to make a decision, in the design, as to what range of operating conditions you are designing for (the maximum height of a tide; the number of days of interruption of stock supply.) In passive resilience, your manner of operation does not change when the threat is present. You can keep operating as normal, because your normal operation is protected by the thing which gives resilience.

Passive resilience is good for policy makers because (i) it requires only a one-off outlay and does not need big expense on maintenance, (ii) it's there for you even if the threat is off the political agenda, and (iii) it is simple to understand and explain.

In active resilience, you have an intelligent system which adapts to the threat and can change its form of operation to become safe under the threat. A multi-skilled person, for example, who changes from being a bricklayer to a violinist, when the construction industry goes into recession and the market for funeral dirges goes crazy. When a new infectious disease emerges, a society with a well designed and maintained emergency response system, rapidly changes its form of operation to stop the disease spreading. In the case of the internet, if one communication node breaks, others nodes will adapt their routing lists accordingly to create a work-around.

Active resilience is more difficult for policy makers because (i) it needs regular expense on maintenance, (ii) it needs to be maintained which is hard to defend when the threat is not in people's minds, and (iii) it is complicated and needs intelligence. Apparently George W Bush had a strategy for dealing with pandemics. However, it lapsed because politicians had other priorities and never dreamt that a pandemic could happen at a time when everything was going so swimmingly well.

Systemic resilience

The third possible type of resilience is systemic resilience. This is where a complex system exists and the system as a whole is resilient. Such is the case of a market, an ecosystem or a living body. When

one part of the system fails, it is lost or sacrificed to the outside threat, but then other parts of the system step in to replace or substitute the failed part, and in this way the system continues.[4]

Flows of true information are vital for systemic resilience, and together with truth: listening, openness, no-blame culture, humility – all the things which allow information to flow quickly, unimpaired and undamaged from source to user.

Systemic resilience might be an aggregation of pieces of passive and active resilience. At the level of a system, the whole has great richness and diversity of elements in it, perhaps with embedded memory of thousands of different threats over the years – and can continually shift its modes of operations if necessary to respond to a myriad of threats.[5]

You have to pay for it

If you want resilience, in whatever form, you have to pay for it. For passive resilience, you have to be ready to design in a great deal of redundancy – features or capabilities which will rarely be used, and therefore seem, at the outset, a frivolity – especially to pragmatic folk holding purse strings. "Why spend money now on building a bridge which you might never need to cross?" Or, the subtler, passive-aggressive objection: "How sure can you be that that is the bridge you will need to cross in the future?"

While most of the spend is up front, the resilience still has to be maintained. A bridge, a sea wall, a fire escape. You need to test the equipment from time to time; you need to review the assumptions on which the resilience was created: is a one-in-a-100-year storm still one in a hundred years? Or is it more like one in ten years? If so, are the flood defences still up to it? Have trucks got heavier so the bridge isn't such a safe escape route?

For active resilience, you need to maintain the system constantly. Readiness and alertness need dedicated roles, applications, working parts which need to be kept fresh and in working order and regularly tested. In the case of a society, resilience might lie in the culture. So the culture needs to be understood, respected and nurtured – it might be just those superfluous, archaic practices whose value you cannot see and which you are tempted to dispense with, which provide resilience.[6]

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[4] In a sense it might be sleight of definition. After the act of replacement or substitution, the system is no longer the same thing – it is changed in some way. So this is a different kind of resilience than where the resilient thing is the same as it was before the threat arrived. But our perception of the system is that it is the same thing (like a river, although the water is different), and perhaps that counts more than the particular definition of the system.

[5] Systemic resilience to individual pieces of resilience might be like the relationship between consciousness and individual senses.

[6] This is, incidentally, where conservatism – or the preservation of the old for its own sake – might have a role not well understood. Over-confident technologists, egotistical architects and townplanners, brash CEOs,

There is an annual cost to maintaining your active resilience (gym membership, pandemic outbreak training, a properly funded financial ethics committee), and if you scrimp on that because the accountants and lawyers can't see the benefit, you're steadily amortising your resilience away. President Trump wouldn't fork out for the annual cost of previous President Obama's Pandemic team which was disbanded in 2018.

To be able to justify paying for your resilience, you have to be able to identify and possibly quantify it – you need to be able to say what you are resiling against. You need to understand the threat or at least the kind of threat, the scale of changes to operating conditions you want your system to tolerate, the modifications to your system which you are prepared to tolerate; and then cost that all out. That takes risk management to a whole new level of sophistication for most organisations in the world.

Yet whatever mathematics or formulae you apply to identifying and quantifying threats and modelling resilience, almost by definition your formula will fall short. The biggest threats can be those which we cannot imagine and cannot count. Good judgment might need to override code and quantification. Don't let the accountants kill off prudence because you can't give them a single number. It could be fatal to misinterpret Peter Drucker and conclude that if you cannot count it, you don't need to deal with it.

Resilience can be a victim of free markets. Although free markets can help resilience, they don't like paying for it. Look at the power sector where liberalised pricing cut prices to the short-run marginal cost of operations – enough to cover the cost of running a power station but not to repay its financing or invest in new plant. The result: no investment in new capacity, and they had to bring in capacity markets to remedy that or separate payments for unused availability. In other liberalised sectors we don't have capacity markets. If we want resilience, we may need to create capacity markets, whether it is for making masks, water pumps, growing food, or guarding truth.

Quantifying it and communicating it

The quantification of resilience is difficult – and it might be impossible. You have a number for the efficiency of the system at each level of operating conditions. So instead of saying "this motor has an efficiency of 28%", you have to say "this motor has an efficiency of 28% in a temperature range of 10°C and 30°C, and of 24% in a temperature range of 30°C to 40°C and 20% in a temperature range of 40°C to 50°C. That is the resilience to one operating condition. But you might want to consider

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reforming bureaucrats or vainglorious politicians, sometimes like to erase the past: physical, cultural, organisational, ecological. Little thought is given to the loss of information, understanding, beauty and good practice and with that the loss of resilience. We are so often unaware of the damage done by reform. Even digging the soil kills worms on whom we depend.
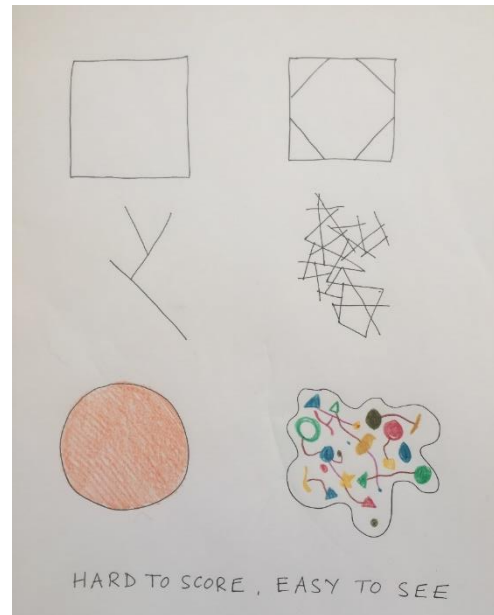
several operating conditions. Suddenly you get something which is complicated, a mouthful – tables of numbers, multiple dimensions bashed down into two, with their legs still wriggling.

Resilience is similar to biodiversity in the way it defies a simple score – it may be that graphical representation would be more effective than numbers for communicating it. Either way, we need to learn to quantify it or, rather, evaluate it and talk about it in a rigorous way. At the same time we have to bear in mind that the evaluation will probably need to be more nuanced and flexible than a simple cost-benefit analysis; it might be fuzzy and it might defy maths.

HARD TO SCORE, EASY TO SEE

Our resilience to extreme threats

That was the theory. Today, Covid 19 tests our resilience in practice. There have been falls of 20%-30% in industrial activity, of 100% in some service sectors, and rapid growth in unemployment figures – 20 million or more in the USA.

Pandemics are one of a few types of rare, extreme threats.[7] All out war happens a couple of times a century at the moment. Global pandemic a handful of times. Global crop failure currently less often, but climate change will create huge regional famines in the foreseeable future.

Our sophisticated society is vulnerable to these threats with our vast, homogenous populations, closely packed as we live out our animal need to meet and congregate, and dependent on elaborate, thick webs of networks for the transfer of goods and information, some exposed to facture.

But we *are* resilient to extreme threats. We are arranged into over 200 separate states, most of which have independent capabilities in food production and generation of warmth, while at the same time being interconnected, and possessing skills of surviving virtually all the climatic conditions present on the planet. We have evolved and developed our society to subdue threats like bubonic plague or winter, which were previously considered extreme.

The issue is that our standard of resilience is very high – we expect to maintain an absurdly large population and even a small number of deaths is a problem to us because of our highly developed moral and emotional nature.[8] If we weren't bothered about losing 5%-10% of the population every

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[7] Extreme ones are by definition rare, because if they happened often, they would be considered normal
[8] Not just highly developed. Also highly selective. Where's the uproar about migrants' deaths at sea or deaths in road accidents. No, for migrants and car crashes we have used resilience technique 11, and what was once horrific is now well within the acceptable boundaries.

so often, which many species have to tolerate quite regularly, then even things like Covid would not be seen to be a problem.

There are, nonetheless, some big common sense gaps in our resilience to extreme threats, these not fully tested by the current pandemic. Four important ones are on my mind:

- The lack of basic skills in urban populations is a huge vulnerability. People can't grow food. They can't cook. They don't know basic healthcare. They are sitting ducks if anything goes wrong. As they don't know what to do, they are dependent on the mass communication of government… yet …
- truth is vital for resilience – emergencies are unforgiving and a higher percentage of decisions taken need to be right. There are too many crooked people willing to sacrifice truth for self-interest, too many media folk willing to amplify those crooks, and too many in the crowd ready to numb their minds, cover an ear, close an eye and hold their nose in support.
- Too many countries depend too much on importing vital things. The UK imports at least 50% of its food. We import face masks and ventilators. We import energy and other key, raw materials. That works in normal operating conditions, but it might make sense to pay for domestic, reserve capacity.
- We depend too much on a very small number of commercially bred crops – rice, maize, wheat, potato and soy. Read the novel *Death of Grass* by John Christopher if you don't think that is a problem.

Added to this, the list of threats is constantly growing longer. We continue recklessly to overwhelm our own resilience – by relentlessly invading and destroying healthy ecosystems – destroying the soil and insects upon which we depend for food; tearing down the forest buffers which guard us from unknown pandemics… on and on.

Five big questions

We will probably return to "normal" life and not really learn much from the pandemic about resilience. Neither in dealing with pandemics or other big risks.

But let's imagine some powerful people are a touch chastised and allow themselves to think humbly, long-term and systemically, and put aside the ego and party-ideology. Perhaps powerful people who came close to death and had low-paid nurses to thank for their survival.

Then what should they think about resilience and risk?

Among the big questions, here are five.

1.   **Why isn't China right?**

China's totalitarian state was, in this case, able to respond immediately to the crisis, without any of the restraints of diversity of opinion. In this case, it seems to have worked (although because they

don't respect truth, you never really know). The EU, a diverse grouping of nations, or the USA, a diverse group of states, were less decisive, less able to control its people, and so the virus appears to have caused more damage.

There is a risk that the experience will strengthen the case for illiberal democracy or illiberalism generally.

The centralised power approach to societal resilience is a big bet. As long as the very powerful actor makes the right decisions, they are ok. But if a single state of 1.5 billion people makes a wrong, centralised decision, it would be a calamitous screw-up. Some of Chairman Mao's policies would be examples of that. China would be more resilient if it were a region of 20 different countries each with a population of 70 million. At least a portion of those would be progressive enough to have stamped out wildlife trade - the source of the Coronavirus - years ago.

The most successful places seem to be countries which are open and progressive, run by women whose egos and ideology didn't get in the way of sorting things out calmly and effectively.

2. What about climate change and biodiversity?

Climate change is the great disruption, the mother of all[9]. There's a field of climate change study called adaptation. It is about how society should adapt to the impacts of climate change. The impact of climate change is to make our operating conditions less favourable and more variable. Therefore, our systems will have to tolerate a wider range of operating conditions, i.e. be more resilient.

Nature is the ultimate resilient system, sorely threatened by one viral species, *homo sapiens.* Biodiversity is the living embodiment of resilience. Be protecting nature, our own society will be more resilient. This is obvious to people who have thought about environmental issues.

In practice, to create resilience to climate change:

-   our farming needs to be more resilient, by switching wholesale to regenerative-organic farming, agro-forestry and permaculture, the ultimate in resilient forms of land cultivation;
-   we have to stop destroying forest, wetland, grassland and other forms of natural land-cover, and then restore hundreds of millions of hectares which we have degraded or destroyed, thereby imperilling our own resilience
-   our food production needs to be more diverse, less dense, and yet with shorter, more robust supply chains;
-   we have to be trained and agile in switching operating modes because pandemics and blights will come thick and fast;
-   we have to have more financial and physical capital tied up in reserve to be able to withstand periods when our normal operations get suspended;

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[9] Try Paul Gilding's book "The Great Disruption"

- we have to be able to handle with compassion and respect mass movements of people escaping from water wars, immense land fires and inundations;
- our homes and workplaces have to be rebuilt to save energy and handle more extremes of temperature without putting more pressure on energy resources.

And on and on.

Whatever the area, it is a lot about understanding and quantifying resilience, and a lot of choices about what is the acceptable minimal standard we want, how much we are prepared to pay for that, and what operating conditions (and combinations of them) we want to prepare for.

Now we've seen how important resilience is in the case of a single virus over a few months, we should redouble efforts to understand how to create resilience to withstand the onslaught of climate change for the next few thousand years.

3. Are we so sure about our acceptable performance levels?

Our acceptable performance levels are the levels of perceived wellbeing or economic activity we want to function at, and which we want to be maintained when operating conditions change. This chosen level forces us to adopt certain systems, with corresponding levels of outcome and resilience. In reality there is a range of acceptable performance for a given system, not a thin line – there is the performance we expect in normal circumstances and the minimum performance we expect in difficult circumstance.

Acceptable performance is usually described by a range of measures – maximum speed, acceleration, consumption or GDP, happiness and employment. Our acceptable performance influences the kind of system we adopt and therefore the resilience available to us. A different bundle of acceptable performance levels (there are usually multiple measures in a system, although in our economic system, one measure, GDP, has a ridiculously excessive influence).

So if we are examining how to be more resilient, let's examine thoroughly what measures we are using to gauge performance, how we weigh them, how much tolerance we have of them, and whether actually they are serving us well - are they really making us as happy as we think and are they incentivising the right operating system?

Through changing our measures of performance, we might enter a new world with different - perhaps more - resilience.

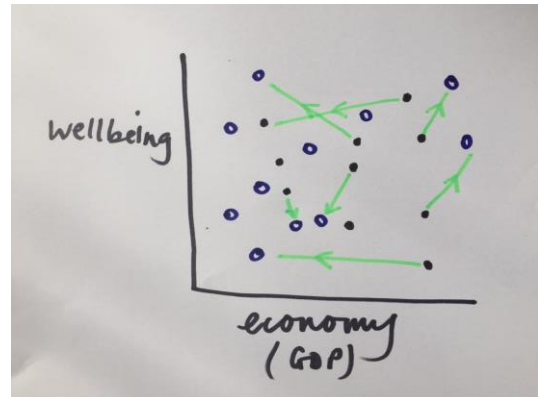## 4. What do the positives of disruption teach us about resilience?

In the case of Coronavirus, the actual disruption itself had many positive consequences. It will take time to catalogue, quantify and value them all, but cleaner skies, cleaner water, more birdsong are wonderful things we have prayed for. For some people less travel, less stress in some ways (more in others, though), time to learn new things, some time to reflect.

Many people did not have those benefits, but many did. To examine them is not to deny the hardship of the many who did not.

What we learn from the positives is that resilient living can have pleasant elements. It is plausible to argue that some forms of resilience have a negative cost.

The graph, right, shows some activities – black spots – which we do under normal operating conditions e.g. drive to work. The blue circles are the corresponding activities we do under resilience mode. The green lines show how we shift from one to the other as we take resilience measures under the disruptive conditions.

The x axis measures the GDP value of the activity and the y axis measures wellbeing. Some shifts improve wellbeing and make the economy worse (not flying); others reduce wellbeing and make the economy worse (not being allowed to go to cafes); others improve wellbeing and boost the economy (the slew of unmissable Netflix shows); some reduce wellbeing but improve the economy (obsessive checking of Covid statistics and the rise of its mini-industry).

When we encounter positives in our resilient response to an emergency, they point to ways we can better organise our everyday life or to reasons to be less fearful of future disruption. Of course, with many advantages come a disadvantage. No longer cycling to work everyday, people's cardiovascular health could deteriorate. So you have to be careful.

This is vital knowledge - it helps planning for future resilience measures and even redesigning large aspects of our society to embed the positive resilience measures into the way we live. Examining thoroughly the positives of resilience measures helps make it easier to get them approved politically. It will be worth spending a great deal of time and money studying this.

5. **Can we improve resilience *and* performance? Yes, and in some vital ways.**

It is usually felt that the efficiency v resilience trade-off plays out in economics. There is an unspoken, even unconscious assumption, that if you want a resilient society, then you will have to pay for it with a lower standard of living. In the mad world where standard of living is judged by GDP, resilience is politically unacceptable.

It does not have to be like that. Back to farming.

Modern, intensive, mono-culture, industrial farming is said by some to be efficient. I think what is meant by efficient here is that farmers are able, by way of all manner of subsidies and damage to
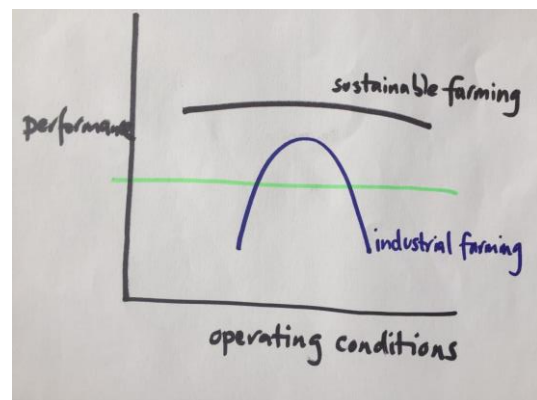
their land, their lifeblood, sell food to multinational food and food retail companies at the lowest prices.

But industrial farming has many disadvantages. It needs poisons to kills off life in the soil and on the land and in the air. It depends on vast machines which crush life out of the soil. It depends on subsidies. It is fuelled by natural gas (for making nitrogen fertiliser). It is dependent and abused by on large agrochemical suppliers. It is vulnerable to drought. Its tendency to monoculture makes it more vulnerable to disease. It causes more greenhouse gas emissions than its sustainable counterparties.

Sustainable farming[10] is more resilient to fluctuations in operating conditions, but thought by some to have inferior performance. Yet if people value healthy soil, insects, worms, birds and trees, clean waterways, nutrient-rich food and healthy rural communities, then the relative performance of sustainable farming leaps ahead of industrial farming. In this way, you can have resilience *and better performance.* Today industrial farming is only just touching the *pareto* line, limping there on state-owned crutches.

This is illustrated in the graph on the right – two systems where the more resilient one also has better performance. This can happen not least because the elements which improve performance actually improve resilience, too.

There are plenty of other areas like this. In healthcare, for example, a healthy person is also more resilient to disease. If we look after ourselves through good diet and exercise, we are more resilient by being more healthy *and* our performance improves. We enjoy life more, and can derive pleasure from those very things which improve resilience, the wholesome food and exercise.

Children walking to school makes them more healthy, saves energy and they have fun on the way; families staying together is good for resilience and wellbeing at the same time. Outdoor hobbies like growing food; strong local communities; sympathetic urban design ... all these can boost resilience and improve wellbeing. Mental, physical, ecological, social and spiritual health tend to be mutually supportive, thus lead to a happier and more resilient system.

Our current modus operandi shows the opposite tendency. We are prone to make ourselves less resilient and less well off. A curiosity of Coronavirus is that the external threat is self-inflicted. It is a direct result of our normal operations. Our normal operations actually increase the likelihood of a threat emerging and make us weaker to withstand it.

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[10] For example, regenerative-organic farming, agro-forestry and permaculture

Conclusion

Coronavirus presented a threat and to avoid that threat we had to change our operations with huge impact on our life. The seriously bad bits are that people died, people got ill and people lost their livelihoods. If we had taken no action, things would have been far worse.

We need to review the resilience of our system to future threats like this and to the mothers of all threats, climate change and loss of biodiversity.

We need:

(i)   to reduce the probability of the threat arising (e.g. another pandemic happening)
(ii)   to ensure that our current modus operandi is not by its nature exacerbating the threat
(iii)   to reduce the impact that the threat has on life, health and wellbeing, if it does materialise.

In order to get fresh answers, we should think more about resilience. This includes how we operate, the range of operating conditions we want to be resilient to, the expected and acceptable performance levels under normal conditions, the measures of performance, the resilience measures to be taken, and the modus operandi under those measures. I think if we make a very rigorous and thorough examination, we will discover additional arguments for speeding up transformation to a more sustainable and compassionate society.

James Atkins, 26th April 2020; revised 9th May 2020