



GLOBAL CATASTROPHES

全球灾变与世界末日

Bill McGuire 著 梁福明 译



通识教育
双语文库

A VERY SHORT
INTRODUCTION



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Preface – Where will it all end?

Que será, será

Whatever will be will be

The future's not ours to see

Que será, será

Jay Livingston and Ray Evans

The big problem with predicting the end of the world is that, if proved right, there can be no basking in glory. This has not, though, dissuaded armies of Cassandras from predicting the demise of our planet or the human race, only to expire themselves without the opportunity to proclaim 'I told you so'. To somewhat adapt the words of the great Mark Twain, the death of our race has been greatly exaggerated. The big question is, however, how long will this continue to be the case?

In answer, it would be perfectly reasonable to say that of course the world is going to end – in about 5 billion years time when our Sun finally runs out of fuel and swells to become a bloated red giant that burns the Earth to a cinder. On the other hand, a fervent eschatologist would undoubtedly contest this, launching into an enthusiastic account of the many alternative and imaginative ways in which our world and our race might meet its end sooner, of which disease, warfare, natural catastrophe, and exotic physics experiments gone wrong are but a selection. Given the current state

of the planet you too might be forgiven for having second thoughts following such a litany – perhaps, after all, we will face ‘doom soon’ as John Leslie succinctly put it in his book *The End of the World*, rather than ‘doom deferred’. Against a background of accelerating global warming, exploding population, and reborn superpower militarism, it may indeed be more logical for us to speculate that the human race’s great adventure is about to end, rather than persist far into the future and across the vastness of galactic space.

VIII

Somewhat worryingly, Cambridge cosmologist Brandon Carter has developed an argument that supports, probabilistically, this very thesis. His ‘doomsday argument’ goes like this. Assuming that our race grows and persists for millions or even billions of years, then those of us alive today must belong to the infinitesimally small fraction of humans living in the earliest light of our race’s dawn. This, Carter postulates, is statistically unlikely in the extreme. It is much more probable that we are alive at the same time as, say, 10 per cent of the human race. This is another way of saying that humans will cease to exist long before they have any chance to spread across space in any numbers worth talking about.

John Leslie illustrates this argument along these lines. Imagine your name is in a lottery draw, but you don’t know how many other names there are. You have reason to believe, however, that there is a 50 per cent chance that the total number is a thousand and an equal probability that the total is ten. When the tickets are drawn, yours is one of the first three. Now, there can be few people who, in such circumstances, would believe that the draw contained a thousand rather than ten tickets.

If the doomsday argument is valid – and it has withstood some pretty fierce attacks from a number of intellectual heavyweights – then we may have only a few centuries’ respite before one nemesis or another obliterates our race, our planet, or both. Despite nearly a quarter of a century in the ‘doom and disaster’ business, however, I can’t help being at least a little optimistic. Wiping out 6.5 billion

or more people at a stroke will not be easy, and many of the so-called ‘end of the world’ scenarios are in reality no such thing, but would simply result – at worst – in a severe fall in human numbers and/or the reduction of our global, technological civilization to something far simpler and more parochial – at least for a time. Personally, therefore, I am open-minded about what Stephen Baxter calls in his novel *Manifold Time* the ‘Carter Catastrophe’. There is no question that the human race or its descendants must eventually succumb to oblivion, but that time may yet be a very long way off indeed.

This might be a good point to look more carefully at just what we understand by ‘the end of the world’, and how I will be treating the concept in this book. To my thinking, it may be interpreted in four different ways: (i) the wholesale destruction of the planet and the race, which will certainly occur if all the human eggs remain confined to our single terrestrial basket when our Sun ‘goes nova’ five billion years hence; (ii) the loss of our planet to some catastrophe or another, but the survival of at least some elements of our race on other worlds; (iii) the obliteration of the human race but the survival of the planet, due perhaps to some virulent and inescapable disease; and (iv) the end of the world *as we know it*. It is on this final scenario that I will be focusing here, and the main thrust of this book will address global geophysical events that have the potential to deal our race and our technological society a severe, if not lethal, blow. Natural catastrophes on a scale mighty enough to bring to an end our familiar world. I will not concern myself with technological threats such as those raised by advances in artificial intelligence and robotics, genetic engineering, nano-technology, and increasingly energetic high-energy physics experiments. Neither will I address – barring global warming – attempts by some of the human race to reduce its numbers through nuclear, biological, or chemical warfare. Instead I want to introduce you to some of the very worst that nature can throw at us, either solely on its own account or with our help.

Although often benign, nature can be a terrible foe and mankind has fought a near-constant battle against the results of its capriciousness – severe floods and storms, devastating earthquakes, and cataclysmic volcanic eruptions. The terrible Asian tsunami of 26 December 2004 provided us with just a taster of the worst nature can do, destroying 400,000 buildings, killing 300,000 citizens from 40 countries – including 100,000 children – and leaving an astonishing 8 million people homeless, unemployed, and impoverished. While the scale and extent of the tsunami's awful legacy are unprecedented in modern times, we have – on the whole – been quite fortunate, and our civilization has grown and developed against a backdrop of relative climatic and geological calm. The omens for the next century and beyond are, however, far from encouraging. Dramatic rises in temperature and sea level in coming decades induced by greenhouse gases – in combination with ever-growing populations – will without doubt result in a huge increase in the number and intensity of natural disasters. Counter-intuitively, some parts of the planet may even end up getting much colder and the UK, for example, could – in this century – be freezing in Arctic conditions as the Gulf Stream weakens. And what exactly happened to the predicted new Ice Age? Has the threat gone away with the onset of anthropogenic (man-made) global warming or are the glaciers simply biding their time?

While rapid in geological terms, climate change is a slow-onset event in comparison with the average human lifespan, and to some extent at least its progress can be measured and forecast. Much more unexpected and difficult to predict are those geological events large enough to devastate our entire society and which we have yet to experience in modern times. These can broadly be divided into extraterrestrial and terrestrial phenomena. The former involve the widely publicized threat to the planet arising from collisions with comets or asteroids. Even a relatively small, 2-kilometre object striking the planet could be expected to wipe out around a quarter of the Earth's population.

The potential for the Earth itself to do us serious harm is less widely documented, but the threat of a global natural catastrophe arising from the bubbling and creaking crust beneath our feet is a real and serious one. Three epic events await us that have occurred many times before in our planet's prehistory, but which we have yet to experience in historic time. A cataclysmic volcanic *super-eruption* plunged the planet into a bitter *volcanic winter* some 74,000 years ago, while little more than 100,000 years ago gigantic waves caused by a collapsing Hawaiian volcano mercilessly pounded the entire coastline of the Pacific Ocean. Barely a thousand years before the birth of Christ, and again during the Dark Ages, much of eastern Europe and the Middle East was battered by an earthquake *storm* that levelled once great cities over an enormous area. There is no question that such *tectonic* catastrophes will strike again in our future, but just what will be their effect on our global, technology-based society? How well we will cope is difficult to predict, but there can be little doubt that for most of the inhabitants of Earth, things will take a turn for the worse.

XI

Living on the most active body in the solar system, we must always keep in our minds that we exist and thrive only by geological accident. As I will address in Chapter 4, recent studies on human DNA have revealed that our race came within a hair's breadth of extinction following the unprecedented super-eruption 74,000 before present, and if we had been around 65 million years ago when a 10-kilometre asteroid struck the planet we would have vanished alongside the dinosaurs. We must face the fact that, as long as we are all confined to a single planet in a single solar system, prospects for the long-term survival of our race are always going to be tenuous. However powerful our technologies become, as long as we remain in Earth's cradle we will always be dangerously exposed to nature's every violent whim. Even if we reject the 'doom soon' scenario, it is likely that our progress as a race will be continually impeded or knocked back by a succession of global natural catastrophes that will crop up at irregular intervals as long as the Earth exists and we upon it. While some of these events may bring

to an end the world as we know it, barring another major asteroid or comet impact on the scale of the one that killed the dinosaurs, the race is likely to survive and, generally, to advance. At some point in the future, therefore, we will begin to move out into space – first to our sibling worlds and then to the stars. In the current inward-looking political climate it is impossible to say when a serious move into space will happen, but happen it will and when it does the race will breathe a collective sigh of relief. At last some of our eggs will be in a different basket. What happens next is anyone's guess. As this book will show, when it comes to geophysics, what will be, will be.

Bill McGuire

Hampton, England

August 2005

前言

不管怎样¹

该怎样就怎样

未来不是我们能明了

不管怎样

杰伊·利文斯顿 & 雷·埃文斯

预测世界末日的的一个问题是，即使预测正确，也不可能享受一丝荣耀。然而，这并没有阻止大批的卡珊德拉²们预测地球或人类的灭亡，结果是他们直到逝去都没有见到地球或人类的灭亡，没有机会宣称“我早就和你们说过”。用伟大作家马克·吐温的话来说，人类的灭亡一直以来都被过分夸大了。但是，这种情况还能持续多久？

当然，我们有充分的理由证明世界正走向末日：大约 50 亿年以后，太阳上的燃料将最终耗尽，它将膨胀成一个巨大的红色球体，把地球烧成灰烬。另一方面，宗教中狂热的末世论

¹ 原文为西班牙语。——译注，下同

² 卡珊德拉 (Cassandra)：希腊神话中特洛伊的公主，不被重视的灾难预言者。

者无疑也支持这一观点，并且想象出各种方式，其中包括疾病、战争、自然灾害、外星人物理实验失败等等，千方百计地说明地球和人类将很快走到尽头。根据地球目前的状况，如果你深思熟虑后依然认为：人类也许终将面临“厄运不久降临”的命运，就像约翰·莱斯利(John Leslie)在其著作《世界末日》(*The End of the World*)中简洁表述的那样，而不是“厄运推迟到来”，你的这种看法或许也是可以理解的。在全球变暖加速、人口爆炸和超级军事大国兴起的背景下，我们的确更有理由推测，人类伟大的冒险旅程不会持续到遥远的未来，不会纵横于浩瀚的宇宙，而是行将结束。

XIV

让人有些担心的是，剑桥大学宇宙学家布兰登·卡特(Brandon Carter)提出的一个观点可能为上述看法提供佐证。他的“死亡日论证”是这样的：假定人类的成长和生存要延续几百万年甚至几十亿年时间，那么现存的这些人只是生活在人类发展的最初阶段，只是占人类总人数微乎其微的一小部分。卡特认为，这种情况在统计上是极不可能的。更有可能的情况是，今天的人口要占据人类总人数的10%。换句话说，早在人类能大规模地进入太空之前，人类已经不复存在。

约翰·莱斯利举例说明了以上观点。假设抽奖箱中有签了你名字的彩票，但你不知道箱子中还有多少其他人的。而同时你有理由相信，箱子中总票数为1,000或10的概率均为50%。在抽奖时，你在前三次就被抽到了。这种情况下，可能绝大多数人会相信箱子中的彩票是10张，而不是1,000张。

如果死亡日论证成立——事实上它已经受住了许多有影响力的学者的猛烈攻击，那么在人类或地球——甚至两者——都被某个复仇女神消灭之前，人类也只有几个世纪的时间。尽管“末日和灾难”的论调持续了近1/4个世纪，我还是不禁有一点乐观。一瞬间消灭65亿或更多的人口并不容易，许多所谓

的“世界末日”的情景实际上不是那么回事，最坏的情况可能只是导致人类数量的严重减少，并且 / 或者使我们的全球技术文明退化为某种更简单、更狭隘的文明，至少在一个时期内是这样。因此，我个人认同史蒂芬·巴克斯特 (Stephen Baxter) 在其科幻小说《多重时间》(*Manifold Time*) 中描述的所谓“卡特灾难”。毫无疑问，人类或其后代最终将消失，但那个时刻距离现在还极其遥远。

这里，我们先仔细看看如何理解“世界末日”和本书中如何使用这一概念。就我的理解，“世界末日”可以有四种解释：(1) 人类将自己的全部期望寄托在地球上，当太阳在距今 50 亿年后演化成一顆新星时，地球和人类肯定会被完全摧毁；(2) 地球遭受这样或那样的灾难，但至少还有一部分人能存活在地球上；(3) 也许由于致命的和无可避免的疾病，导致人类灭绝，但是地球依然存在；(4) 我们所理解的“世界末日”。本书将集中讨论最后一种情况，即一些全球性的地球物理事件，这些事件即使不是致命的，但也可能给人类和技术社会带来沉重的打击。有些自然灾害威力巨大，足以使我们熟悉的世界到达末日。在这里，我们不论来自高科技的威胁，例如人工智能和机器人科学的发展、遗传工程、纳米技术、以及逐渐强大的高能物理实验，也不论一些人提出的除全球变暖之外的减少人类数目的方法，如核战争和生化战争。本书将介绍自然界可能带给人类的一些严重威胁，其中一些由自然界本身产生，另外一些则是由人类催生的。

虽然大自然在多数情况下都是温和的，但它也可能变成可怕的敌人，而人类几乎在永无休止地与大自然的变化无常作斗争——包括大洪水、大风暴、灾难性的地震和火山喷发。2004 年 12 月 26 日，亚洲爆发骇人的大海啸，40 万间房屋被毁，40 个国家的 30 万人丧生，其中有 10 万儿童，无家可归、失业和陷入贫困的人数高达 800 万。大海啸只是让人类见识了一下大

自然最厉害的一面。尽管大海啸的范围、强度及其所造成的损失在当代是空前的，但总的来说我们还是幸运的，人类文明还是在相对平静的气候和地质背景下得以成长和发展。然而，种种迹象表明，下个世纪及以后的前景很不乐观。在未来几十年，温室气体引起的温度骤升、海平面猛涨以及持续的人口增长无疑将导致为数更多、破坏性更大的自然灾害。与我们的直觉相反，地球上的一些地方可能变得更冷，例如，一旦墨西哥湾洋流减弱，英国将在本世纪内与北冰洋一样寒冷。在预期的新冰期内又会发生什么情况呢？人类活动引起的全球变暖使这一新冰期威胁消失了吗？还是冰川只是在伺机卷土重来？

XVI

虽然气候变化在地质学上是快变现象，但与人的平均寿命相比则变化较慢，至少在某种程度上可以被测量和预报。而更突然、更难预报的是那些足以摧毁我们整个社会、目前还未曾经历的地质大事件。这些事件可大致分为地球以外和地球本身这两种情况。前者包括地球与彗星和小行星撞击所造成的威胁，这一点已广为人知。即使一个相对较小的、直径 2 公里的物体与地球碰撞，预计也将毁灭地球 1/4 的人口。

虽然地球本身可能给人类带来严重伤害的潜在能力还没有得到广泛证实，但我们脚下时刻运动着的地壳能够带来全球自然灾害这一威胁对我们来说则是真切而严重的。等待我们的有三个重大事件，它们在地球史前时代已经发生多次，但我们在有史时期尚未经历。大约在 7.4 万年前，一次灾难性的火山超级喷发使地球陷入了寒冷的火山冬季。大约 10 万多年以前，由夏威夷火山崩塌掀起的巨浪无情地袭击了整个太平洋沿岸。地震风暴在耶稣诞生前仅 1,000 年曾发生过，后来在黑暗时代¹再次发生，袭击了东欧大部分地区和中东，将辽阔土地上的许多曾

¹ 黑暗时代 (the Dark Ages): 欧洲历史上早于中世纪的一段时期，指公元 5 至 10 世纪。

经宏伟的城市夷为平地。毫无疑问，这类地质构造上的灾难未来将再次袭击我们，这一类灾难会对我们这个依赖技术的全球化社会产生什么影响呢？很难预测我们是否能有效应对，但确定无疑的是，对地球上的大多数居民来说，形势将更加严峻。

生活在太阳系中最具有活力的星体上，我们必须时刻牢记，人类的存在和繁荣完全是由于地质偶然事件。正如本书第四章将提到的，近来对人类 DNA 研究显示，在距今 7.4 万年前，曾发生过史无前例的超级火山喷发，人类险遭灭绝。如果我们在 6,500 万年前就已存在，当一颗直径为 10 公里大小的星体撞击地球时，人类就与恐龙一起灭绝了。我们必须面对这样的事实，只要所有人类都还被拘于单一的太阳系中的单一星体上，人类长期生存的前景就是脆弱无力的。不论将来的技术如何强大，只要我们依然在地球摇篮中，我们随时都有可能遭受自然界的猛烈袭击。即使我们不接受“厄运不久降临”的前景，但只要地球存在，而且我们还生活在地球上，全球自然灾害将不时发生，人类的进步将会受到它们的持续阻碍，甚至出现倒退。尽管其中一些事件会把我们带到已知的世界末日，但除非再一次出现导致恐龙灭绝的小行星或彗星撞击地球的严重事件，总的来说，人类还是有存活和发展的可能。在未来某个时刻，我们将开始离开地球，进入太空，首先迁徙到与地球属性相同的世界，然后再到其他星体。在目前内倾的政治环境下，我们不可能确定人类何时能正式迁入太空，但一定会的，届时人类将长舒一口气：终于不用再孤注一掷了。接下来还会发生什么，人们尽可在想象的空间里自由翱翔。本书将从地球物理学角度说明，未来是什么样只能顺其自然。

比尔·麦圭尔
于英国汉普顿
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