

the chances of heavy rain, such as that experienced the UK during last month's storm Desmond, – by anything from 5 to 80 per cent.

The conclusion is that the past cannot be a reliable guide to the future. Can climate models help? To a degree, yes, but they are not yet accurate enough on a local scale to be a reliable guide for much flood defence planning.

This doesn't mean that deluges of the kind we have recently seen in the UK are bound to occur each winter. Climate change is loading the dice towards flooding, but we are still likely to have dry years and even droughts.

This all makes life very hard for designers of flood defences and reservoirs. They will have to model how their systems respond to a wider range of conditions. They will also have to devise ingenious schemes that do not fail catastrophically, even when surprising patterns of rainfall occur. And they need to think about how to build in capacity to adapt to unforeseen change.

More surprising stuff is going to occur – that's what happens when you kill stationarity. ■

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Jim Hall is professor of climate and environment risks and director of the Environmental Change Institute at the University of Oxford

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While the dominant soda tax debate has increased awareness of the hazards of consuming a lot of sugary drinks, it has detracted from nudging people to eat less and select a balanced diet.

The UK government has promised to unveil its strategy on tackling obesity soon. If it does go for a soda tax, which is now being hinted at, this looks likely to make no more than a token dent in consumption. Different actions would be needed to truly curb diet-related ill health. ■

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Tom Sanders is emeritus professor of nutrition and dietetics at King's College London

## ONE MINUTE INTERVIEW

# I plant memories in seeds

As our appetite for data soars, **Karin Ljubic Fister** is pioneering a surprising storage facility with potential to grow



### PROFILE

Karin Ljubic Fister is a doctor at the University Medical Centre Maribor, Slovenia, and also works in computer science and genetics. She presented her work on plant-based data storage at the Falling Walls Lab conference in Berlin, Germany

### You put data into plants. Why?

I was annoyed about the amount of disc space on my computer. I started wondering, what if I could store data in DNA? It's such an immense reservoir of potential storage – 1 gram of it could store over  $450 \times 10^{18}$  bytes. All of the archives in the world could be stored in one box of seeds.

### What was your first challenge?

Together with colleagues, we inserted a simple computer program called "Hello World" into a tobacco plant's DNA.

### How do you put computer code into DNA?

First you need a coding system. A computer program is basically a sequence of 0s and 1s, so we transformed this into the four DNA "letters" – A, G, C and T – by turning 00 into A, 10 into C, 01 into G and 11 into T. Then we synthesised the resulting DNA sequence. We transferred this artificial DNA into a bacterium and infected the leaf of a tobacco plant with it. The bacterium transfers this artificial DNA into the plant.

### What happens to the data once placed inside the plant?

We took a cutting of the infected leaf, planted it, and grew a full tobacco plant from it. This is essentially cloning, so all the leaves of this new plant, and its seeds, contained the "Hello World" program encoded in their DNA.

### How do you retrieve the data?

It's not hard. You extract the plant's DNA and sequence it using standard methods. We reconstructed the program from the resulting tobacco seedlings with complete accuracy: the message "Hello World" popped up on our computer screen.

This sort of data extraction means the destruction of some leaf material, but handheld technology is already in development that will one day enable us to read a leaf's DNA directly, with virtually no damage.

### So one day we'll be able to browse Wikipedia from a plant?

Absolutely, with the appropriate interface – though in that scenario you would not be able to edit any entries, because data stored in DNA is read-only. That's why it would ultimately be better suited to archiving.

### How long can data stored in seeds last?

Inside the global seed vault they can be frozen and last for millennia – there's no limit. They even have their germination ability preserved.

### What future do you see for this technology?

Imagine walking through a park that is actually a library, every plant, flower and shrub full of archived information. You sit down on a bench, touch your handheld DNA reader to a leaf and listen to the Rolling Stones directly from it, or choose a novel or watch a documentary amid the greenery.

A simple tree could provide all the educational data a child anywhere in the world could need. That was my inspiration.

**Interview by Sean O'Neill**