A Roundup of Roundup® Reveals Converging Pattern of Toxicity from Farm to Clinic to Laboratory Studies

We need to ban glyphosate from our own communities as most governments fail to protect citizens

Dr Eva Sirinathsinghji

Forward this article to your MEPs and ask them to vote against the re-approval of glyphosate herbicide
Also, please support research of Seralini's team on analysing glyphosate residues in rats exposed to Roundup here: http://www.i-sis.org.uk/Support_Seralini_Team_for_New_GMO_Risk_Research.php

What is glyphosate?

Glyphosate, perhaps surprisingly for a chemical so ubiquitously associated with our food, was not first used as an agricultural chemical but instead first patented as a metal chelator in 1964 by Stauffer Chemical company (US 3160632 A) [1] and used as an industrial pipe cleaner. It was later patented by Monsanto as an herbicidal agent in 1974 (US3799758 A) [2] based on its ability to block the shikimate pathway involved in the production of aromatic amino acids in both plants and bacteria. It has become the most popular herbicide in the world especially since glyphosate tolerant genetically modified (GM) crops were commercialized in the mid-1990s, together with the assumption (perpetrated by Monsanto) that the herbicide is safe for health and the environment. In 2010, it was also patented by Monsanto as an antibiotic agent. Moreover, it is being increasingly used as a pre-harvest desiccant for drying seeds, a process that results in contamination of non-GM grains, one of the main exposure routes in the EU where GM crops are not commonly grown. Thus, an estimated 70 % of UK oil seed rape (canola) and 50-60 % of EU sunflowers are sprayed with glyphosate [3], resulting in products of major food brands in the UK testing positive for glyphosate residues in a 2014 analysis by GM Freeze, with glyphosate the most commonly detected of all chemicals [4].

All of glyphosate's chemical properties already mentioned have implications for the health of both people and planet. Scientific research has additionally implicated glyphosate as an endocrine disruptor and a DNA mutagen; and it affects over 291 different enzymes in the body [5]. It is increasingly linked with a wide variety of illnesses, the sharp rises in illnesses occurring in parallel with glyphosate application across various GM cultivating regions of the world.

The most convincing evidence of glyphosate toxicity is the consistent pattern of diseases associated with glyphosate that has emerged from the farm to the clinic and from scientific studies to citizen testimonials.

Glyphosate widespread in the environment and in our bodies

Glyphosate's popularity is due in large measure to its concomitant use with the most widely planted type of GM crops, those tolerant to glyphosate-herbicides. Monsanto commercialised the first Roundup-ready crop in 1996 (Roundup being the commercial formulation containing 'adjuvants' that make it much more toxic than the active ingredient glyphosate alone, see later). In countries such as Argentina where large swaths of the country have been dubbed soy deserts, GM soybean cultivation has resulted in an 858 % rise in glyphosate use (see [6] Devastating Impacts of Glyphosate

Use with GMO Seeds in Argentina, to appear). Similarly, the US has seen even greater rises of 2 500 % from 1987 to 2007 [7].

This widespread and massive application of glyphosate herbicides has resulted in almost ubiquitous contamination of the environment. A 2014 study on US water systems across 38 states found glyphosate and its principle metabolite AMPA (aminomethylphosphonic acid) not only in rivers, lakes and streams, but also rain, soil and sediment, ditches and drains and groundwater (see [7]). Some 70 % of rain samples tested positive for glyphosate. Similarly in Europe, (in Catalonia, a large region of Spain) it was found that all 11 groundwater sites were positive for glyphosate despite it being a region free from glyphosate-tolerant crop cultivation; 41 % of samples were above detection limits [8]. ***The detection in groundwater goes against one of the claims on glyphosate safety that its propensity to bind to soil and sediment means it will not leach into our fresh water supplies.*** In Argentina, new data of rain sample measurements averaged an extreme 6.5 µg/L and reaching as high as 67 µg/L (67 ppb) across four regions from October 2012 to April 2014 [9]. These levels are far higher than those seen in US rain samples where the average and maximum concentrations were 0.11 µg/L and 2.5 µg/L respectively [7].

Tap water and rivers also test positive for glyphosate with UK samples coming up (30 parts per trillion (ppt) and 190 ppt respectively) at concentrations within range of those found to be toxic in lab studies (see [10] How Roundup Poisoned my Nature Reserve, *SiS* 64). Urban areas also get sprayed, prompting London citizens to organise banning campaigns of glyphosate spraying in public areas including child-friendly zones [11]. Even oceans are not spared from glyphosate poisoning, with run-offs into the sea persisting for up to 267 days in sea water obtained from the Great Barrier Reef and tested in the lab [12].

Due to the official 'safe' status of glyphosate, data on how much we are being exposed have been scarce, forcing citizen activists and civil society organizations to find out for themselves. Friends of the Earth Europe commissioned an analysis of 182 volunteers across 18 EU countries and found detectable levels in 44 % of urine samples [13] with concentrations ranging from 0.16 ug/L average in Switzerland, to 1.82ug/L in Latvia. Of the UK citizens tested, 7 out of 10 were positive. In the US, urine samples show concentrations 8 times those in Europe [13]. The analysis, commissioned by Moms Across America, also tested 10 mother's breast milk, which came up positive for glyphosate with levels ranging from 76 µg/L to 166 µg/L (76-166 ppb) (see [14]). These levels are 760 to 1600 times higher than the European Drinking Water Directive allows for individual pesticides, and raise obvious concerns as they fall within the range of concentrations at which developmental toxicity has been observed in animal studies (see below). This analysis is the only study on breast milk to date, as no government or public health body has found it necessary to carry out any study on bioaccumulation in internal organs and tissues or in breast milk fed to infants.

Recent independent scientific studies have backed up the work of activists and civil society organisations. Awad Shehata and colleagues in Germany looked at glyphosate levels in the urine of both chronically ill and healthy people, and found significantly higher levels in ill people in samples taken from 102 and 199 healthy and chronically ill people respectively [15]. Those who ate predominantly organic food had lower levels, along with livestock that were fed conventional versus genetically modified feed. The study also looked at levels in cow tissues as well as urine. ***Detection of***

glyphosate in the tissues contradicts one of the assumption-based arguments used by industry and regulators that due to glyphosate's high water solubility, it is rapidly excreted from the body and therefore risks of harm are negligible. In such a case, the levels of glyphosate in urine would be expected to be much greater than levels found in the tissues. However, urine levels in cows averaged 27-42 µg/ml (27-42 parts per million (ppm)), while the level in tissues (intestine, liver, spleen, kidney and muscle) averaged between 14-20 µg/ml, which is within range of urine levels. Though they did not compare glyphosate levels in urine and internal organs of the same cow, the average levels across all cow samples dispute the assumptions taken by regulators that glyphosate does not remain in the body at levels that can cause harm.

In summary, glyphosate is almost ubiquitous in our environment and in people and livestock; it has even been discovered in hospital feeding tubes for child cancer patients in the US [16]. The impacts are described below.

A birth defect epidemic in people and animals

Argentina is one of the biggest cultivators of GM soybeans and the country has witnessed a sharp increase in serious illnesses since cultivation began. Concerned doctors and health practitioners founded the Network of Physicians of Crop Sprayed Towns and met in 2010. They presented data showing increased incidence of birth defects, spontaneous abortions, infertility, still births, cancers, Down's syndrome, mental disability, immune and endocrine disorders, as well as acute effects such as increased convulsions in epileptic patients at time of fumigation, respiratory and dermatological problems (see [6]) and [17] Pesticide Illnesses and GM Soybeans, *SiS* 53) [18].

The Network, together with a large citizen movement, is pushing for a complete ban on aerial spraying of agrochemicals plus a ban of its use within a kilometre of residential areas. They documented a 2-5 times increase in birth defects in sprayed towns compared to before spraying began. Common defects include neural tube defects, which are replicated in laboratory studies on glyphosate (see later).

A 2013 report from the Centre of Congenital defects claims that nationally, the number of cases has not gone up, but a closer scrutiny gives a different picture. Data gathered during a 6 month period from the hospital Maternidad Provincial in Córdoba showed that despite recording a low level of birth defects of 36 out of a total of 2140 births (1.68 %), 22 of those came from mothers living in crop-sprayed towns, which accounts for 61 % of all the birth defects (see [6]).

The US has seen a surge in neural tube birth defects (anencephaly) in the Yakima River, Washington State. The source remains a mystery to officials who have ruled out common causes such as low folic acid and lifestyle choices. Rates have reached 8 cases per 10 000 births from 2010-2013 compared to a national average of 3 cases per 10 000 births. Glyphosate has emerged as a prime suspect as the state of Washington use herbicides, most often glyphosates, to kill noxious weeds in both land and water. An estimated 146 pesticides were applied in the area in the year 2000, and studies are now needed to confirm whether or not glyphosate, either alone or in combination with other chemicals is responsible for neural tube defects in the area [19].

Reproductive problems such as miscarriages and infertility have also risen in Argentina (see [20] Glyphosate/Roundup & Human Male Infertility, *SiS* 62). Physicians of sprayed towns have recorded as many as 23 % of women suffering from miscarriage in the last 5 years [18].

The latest victims of Argentina's chemical agricultural system, of which GM cultivation is an extreme example, could very well have been spared if the evidence of the teratogenic properties of glyphosate produced by industry since the 1980s had not been dismissed [21]. Monsanto's own toxicology tests submitted to the EU commission showed evidence of teratogenicity (see [22] EU Regulators and Monsanto Exposed for Hiding Glyphosate Toxicity, *SiS* 51). The submitted test reports describe rats and rabbits with skeletal abnormalities including the development of a 13th rib in offspring, as well as cardiac abnormalities. Scientific studies such as that of the late Professor Andrés Carrasco reporting neural tube birth defects in frog and chick embryos exposed to agricultural concentrations of glyphosate [23] have validated both Monsanto's findings and clinical observations (see also [24] Lab Study Establishes Glyphosate Link to Birth Defects, *SiS* 48). Probing into the mechanisms underlying the defects, Carrasco discovered that glyphosate disrupted retinoic acid activity, a well-known regulator of developmental processes.

Epidemiological studies have linked increased incidence of birth defects (spina bifida, circulatory/respiratory anomalies, tracheo-esophogeal defects, gastrointestinal defects, urogenital defects, cleft lip, adactyly, clubfoot, musculoskeletal anomalies, Down's syndrome and other birth defects) and reproductive toxicity in those who live near agrochemical-sprayed fields [25-27] while other lab studies are accumulating evidence of birth defects and reproductive toxicity in a range of animals from rats to catfish [28-31].

Evidence from the farm follows the same pattern. Ib Borup Pedersen recently documented personal experiences on his pig farm, where removing GM soybean feed from the diet resulted in pronounced improvement in the health of his pigs, reducing medicine use by a third and increasing his profits (see [32] "Changing from GMO to Non-GMO Natural Soy, Experiences from Denmark, *SiS* 64). Profits were also increased due to his sows living longer and giving birth to more piglets. After researching glyphosate and GMOs Ib investigated further and collaborated with scientists in Germany who analysed 38 of his 1-day old deformed piglets, finding glyphosate in various organs of the pigs. Pigs suffered defects ranging from severe to mild, including spinal, cranial defects and others affecting limbs, gender, internal organs, tongue and more. Many appear to be neural tube defects as seen in the clinic and laboratory.

Cancer rates skyrocket in South American regions of GM cultivation

Neighbourhood resident organisations such as the association of Mothers of Ituzaingo, in collaboration with the Network of Sprayed Towns have been mapping cancer incidence in their towns for many years to draw attention to the epidemic they are facing. It is has reached the point where now, 30 % of all deaths in these regions are from cancers, affecting both adults and children. Cities such as Hernando have seen a 258 % rise in cases between 2001-2002 and 2010-2012 [6].

Rises in cancer rates can be explained by glyphosate's role in cancer-causing mechanisms including DNA damage and endocrine disruption. Endocrine disruption may well also underlie some of the reproductive and teratogenic effects of glyphosate described above. Lab studies show glyphosate damages DNA in lab animals as well as in people who were exposed to the chemical in Argentina [33-35]. It also disrupts cell cycle regulation that can lead to increased cell division and cancer development [36,37]. The glyphosate metabolite AMPA was also shown in a 2014 study to induce DNA damage in

fish at concentration ranges previously documented in streams and surface water in N. America [38]. Glyphosate's carcinogenic potential has been documented since the 1980s (see [39] Glyphosate & Cancer, *SiS* 62)

Distinct from DNA damaging properties, glyphosate also mimics oestrogen at very low levels and promotes the growth of hormone-dependent breast cancer cell lines [40]. Actually glyphosate is an endocrine disruptor and alters the expression of multiple hormones including testosterone, leutinising hormone, follicle-stimulating hormone, and the aromatase enzyme complexes that convert testosterone to oestrogen [31, 42, 42].

Epidemiological studies corroborate lab studies and reports from local citizens in Argentina and the US [43-45]. The Ministry of Health of Córdoba in Argentina reported in June 2014 the doubling of cancer cases in high agrochemical use areas compared to the national average [46]. Consistently, a new meta-analysis found association between glyphosate and cancers following occupational exposure [47]. The study looked at all epidemiological papers on non-Hodgkin lymphoma (NHL) incidence that had been published in English since 1980 that reported agricultural, occupational exposure to specific pesticides. A total of 44 papers were analysed, covering 80 active ingredients and 21 pesticide chemicals, finding the strongest associations between pesticides and specific subtypes of NHL, including an association between glyphosate and B lymphoma. They also found that phenoxy herbicides, carbamate insecticides, organophosphorus insecticides and the active ingredient lindane, an organochlorine insecticide, were positively associated with NHL.

The most comprehensive GMO feeding study to date carried out by Gilles-Eric Séralini and his team, looked at the effects glyphosate and glyphosate tolerant maize NK603 on rats during their life-time (2 years). It showed increased incidence of tumours (including cancers), other illnesses, as well as reduced life-span and altered hormone status [48]. The 2012 publication was aggressively attacked by industry and its supporters and unilaterally and illicitly retracted a year after publication following the appointment of an ex-Monsanto employee as an editor for the journal (see [49] Retracting Séralini Study Violates Science and Ethics, *SiS* 61). It has subsequently been republished elsewhere [50] after massive public protest (see [51] Open Letter on Retraction and Pledge to Boycott, *SiS* 61).

Fatal kidney disease epidemic across continents foreseen by lab studies

Kidney disease has reached epidemic levels in regions that heavily use glyphosate such as farmers in Sri Lanka and sugar cane workers in Central America. Kidney problems have been highlighted by scientific studies, including Séralini's rat feeding study where kidney tumours were observed [50]. A meta-analysis of feeding studies conducted by Séralini's lab revealed kidney pathology in animals fed Roundup Ready soybeans, while *in vitro* studies have shown that glyphosate had cytotoxic effects on human embryonic kidney cell lines [52,53] (see [54] GM Feed Toxic, Meta-Analysis Confirms, *SiS* 52, [55] Death by multiple poisoning ,glyphosate and Roundup, *SiS* 42).

In Sri Lanka, chronic kidney disease of unknown aetiology (CKDu) has afflicted the agricultural population in recent years. A study published in 2014 linked glyphosate-based herbicides to the epidemic. It appears that hard water in the agricultural regions leads to heavy metal toxicity in the kidneys via glyphosate's metal chelating activity, and is responsible for the 400 000 cases of the disease and 20 000 fatalities [56] (see [57] Sri Lanka Partially Bans Glyphosate for Deadly Kidney Disease Epidemic, *SiS* 62). The

government temporarily banned glyphosate from hard water areas, but this decision was reversed due to a lack of agricultural workers to take over the manual weeding required without the application of glyphosate. Similar health problems are widely affecting communities in Central America with one in four sugar cane workers reporting kidney disease in some areas [58, 59]. This epidemic forced the El Salvador government to call for international help after the epidemic began overwhelming the health systems. The El Salvadorian government has since approved legislation to ban glyphosate herbicides, though this is yet to be enforced.

Digestive illnesses widespread

Digestive illnesses plagued the pig farm in Denmark (mentioned earlier) while they were being fed GM soy. When GM produce and glyphosate were removed from their diet, the pigs no longer suffered chronic diarrhoea, which was so severe that 30 % of new born piglets were dying as a result (see [32]). Chronic botulism, caused by the *Clostridium botulinum* bacteria, has also been on the rise in livestock in Germany, the US, and UK since the 1990s [60]. The latest study shows that glyphosate results in dysbiosis of the cow gut, with a reduction of beneficial bacteria in the rumen of cows accompanied by a rise in *C. botulinum* microbes [61].

The digestive illnesses in livestock mirrors a growing health problem in the West, particularly in the US where food intolerances, allergies, celiac disease, bowel diseases, infections and other problems continue to become more common. Nancy Swanson and colleagues showed a clear correlation between spikes in both inflammatory bowel disease and intestinal infection with glyphosate in the US [62]. Deaths from intestinal infections have risen from less than 0.25 deaths per 100 000 in 1979 to over 80 deaths per 100 000 in 2010. Inflammatory bowel disease has risen from around 3 diagnosed cases per 100 000 in 1990 to almost 90 per 100 000 in 2010. Moms across America's testimonials reflect the evidence from the farm and science studies, with children who come off GM and glyphosate covered foods reducing the severity of allergy symptoms as well as other problems such as regular vomiting [63]. With glyphosate's antibiotic properties, it had already been previously shown to cause disruption of the gut bacteria in poultry, swine and cows [64-66]. *Salmonella* and *Clostridium* are highly resistant to glyphosate, whereas *Enterococcus*, *Bifidobacteria*, and *Lactobacillus* are especially susceptible. Perturbation in the balance of these microbial species is associated with digestive disorders such as celiac disease. Similarly, chronic botulism in cows is rectified in livestock by feeding fermented and pro-biotic foods along with charcoal and humic acids. These both bind to the toxins produced by the bacterial pathogen. This treatment also reduces the urinary content of glyphosate, suggesting its binding as an underlying mechanism in the recovery of the infection (see [66]).

Autistic people are well known to have disturbed intestinal function and dysbiosis of the gut. Autism rates are also spiking in parallel with glyphosate use in the US and glyphosate's antibiotic activity may well be an underlying mechanism behind this. Indeed, mothers have also documented much improved autism symptoms in their children upon giving them a glyphosate and GM-free diet.

Health of American citizens deteriorating

One argument for the safety of GM food and their associated pesticides is that the US has been consuming them for years without ill effect. However, in the absence of

labelling GM foods, it is illegitimate to make such a claim. On the contrary, there has been a drastic deterioration of public health in the US since GM crops were introduced. A new publication by Swanson and colleagues plots the rise of 20 chronic diseases using available US government data, all correlating closely with increasing glyphosate application to corn and soy crops, especially over the past several years. The diseases included cancers, Parkinson's, autism, obesity, diabetes, heart disease, digestive disease and kidney failure [62]. Correlation does not prove causation, but such strong association certainly cannot be dismissed, especially in combination with the plethora of other evidence from laboratory studies, and the experiences of doctors in their clinics and farmers in the fields. For a detailed analysis of the study please see [67] Marked Deterioration of Public Health Parallels Increase in GM Crops and Glyphosate Use, US Government Data Show (*SiS* 65).

Though heart disease had not been studied as extensively as cancers and birth defects in relation to glyphosate, the above study implicates its role in cardiac dysfunction. This is corroborated by the new finding that glyphosate formulations cause abnormal heart rhythms (arrhythmia) by interfering with the electrical activity of heart cells in rabbits [68].

A new study published in 2015 finds a correlation between glyphosate use and pineal gland pathology. The pineal gland is located in the brain and is known to regulate circadian rhythm through melatonin secretion. Glyphosate is hypothesised to disrupt melatonin metabolism, as well as induce pineal gland neuropathology through aluminium-induced hypoxia that results from the metal chelating properties of glyphosate. In this way, glyphosate use tightly correlates with the rises in sleep disorders as well as other disorders with symptoms of sleep dysfunction such as autism and dementia [69].

It is becoming clear that glyphosate has multiple toxicities that link it to many diseases through its metal chelating, antibiotic, endocrine disrupting, and genotoxic properties. Glyphosate also has the ability to block cytochrome P450 (CYP) enzyme activity, a class of enzymes involved in detoxifying xenobiotics amongst other things. Glyphosate therefore not only is a toxin in its own right, but enhances the toxicity of other chemicals by preventing the CYP enzymes from detoxifying the body [70].

Americans are definitely getting sicker in numerous ways highly correlated with adopting GM crops and rise in glyphosate use [67] and, as shown by all the testimonials from Moms across America, peoples' health improves after removing GMOs and glyphosate residues from their foods by buying organic [63].

Environmental toxicity a concern for biodiversity, agriculture and sustainability

The spread of glyphosate-resistant weeds is increasingly compromising the effectiveness of the herbicide. There are now a reported 31 species of resistant weeds, up from 23 a year ago as recorded by the Weed Science organisation in the US [71]. In Brazil, an aggressive spread of weeds prompted a former DuPont agronomist to acknowledge the difficulties faced by farmers cultivating glyphosate-tolerant GM crops both in Brazil and Argentina [72]. Monsanto now recommends an 'integrated weed management' strategy that includes tilling the soil (of previously no-till land) and using multiple herbicides. The main selling points of Monsanto's Roundup Ready (RR) GM crop system was to reduce environmental damage through no-tillage agriculture and glyphosate use – a supposedly 'safe' herbicide compared to older chemicals. Not only is glyphosate toxic to health and

the environment, but a cocktail of even more lethal herbicides have to be deployed to deal with glyphosate-resistant weeds, and an end to no till agriculture, resulting in further soil erosion. In short, we have an ecological and agronomic disaster.

Glyphosate toxicity to wildlife is well-documented. Many species, including aquatic organisms, reptiles, beneficial soil organisms including certain microbes and worms have been shown in scientific studies to be affected by glyphosate exposure (see [73] Ban GMOS Now, ISIS special report). This includes chronic and acute toxicity to the model aquatic organism *Daphnia magna* at below accepted thresholds for glyphosate presence in US freshwater [74]. Amphibians, the most endangered animals in the world, are so sensitive to glyphosate that 78 % of frogs died in one study on being exposed to Roundup herbicide [75]. Glyphosate has also been shown to stimulate the growth of soil fungi, increase the pathogenicity of soil pathogens such as *Xylella fastidosa* while numerous beneficial soil organisms have been decimated [76] (see [77] Scientists Reveal Glyphosate Poisons Crops and Soil, *SiS* 47). The latest study on soil organisms concluded that non-target organisms are at risk of local extinction after finding sub-lethal doses of glyphosate reduced fertility as well as survival of juvenile and adult *E.fetida* worms [78]. Monarch butterfly decline has been linked to glyphosate destruction of the milkweed in the US, the only food source for its larvae. Their migration from the US is at an all-time low and has been declining for the last 17 years (1994-5 to 2010-2011) (see [79] Glyphosate and Monarch Butterfly Decline, *SiS* 52) [80]. This decline has prompted a move to protect the butterflies under the Endangered Species Act by over 200 organisations and 40 scientists in November 2014 [81]. A new report on a Welsh nature reserve documents the decline in insects including beneficial pollinators such as bees as glyphosate levels increase (see [9] How Roundup Poisoned my Nature Reserve, *SiS* 64).

Not only are non-target organisms negatively affected, but also the target crops. Glyphosate's metal chelating properties reduce the micronutrients available to the plant, which it needs to maintain a fully-functioning immune system, thereby increasing its susceptibility to disease. This mechanism is thought to underlie the spread of over 40 crop diseases in glyphosate-tolerant GM crops (see [82] USDA scientist reveals All, *SiS* 53). Indeed, USDA senior scientist Don Huber states that glyphosate's ability to kill plants is through the destruction of their immune system. This was clearly demonstrated by his experiments showing that non-GM plants grown in a sterile soil do not die when sprayed with glyphosate as the pathogens are not there to take advantage of the compromised immune system.

A reduction in mineral nutrients has health impacts on those eating the crops such as abnormalities in calves that are caused by manganese deficiency, which are on the rise and may well result from glyphosate chelation [83]. Farm animals are further suffering from other illnesses (and birth defects) as described by the Danish pig farmer earlier. Similar problems have been reported in Germany, where cows are suffering from chronic infections such as botulism [60] and in the US, with for example, the veterinarian Art Dunham reporting botulism in dairy cows, as well as reproductive problems, bloody bowels, rickets and viral diseases in hogs [84].

As a result of the problems faced by farmers, many are now moving away from GM and glyphosate-based systems. The US is seeing a growth in the non-GM seed market (see [85] Global Status of GMO and non-GMO crops, *SiS* 62). Agriculture experts such as Howard Vlieger are helping 300-400 farmers in the US switch from GM to non-GM crops without glyphosate use due to its ill effects to soil, plants and animals [86]. Glyphosate-

tolerant crops have also been shown to need more water and do worse in drought situations (see [87] GM Crops and Water – A recipe for Disaster *SiS* 56, and [88] GM Crops Destroyed by US Drought but non-GM Varieties Flourish, *SiS* 56). This is consistent with their health being compromised by glyphosate.

While GM crops are causing problems for farmers, non-GM crops are leading the way in providing drought- and salt-tolerant varieties, which makes sense when one considers that the majority of traits are highly complex, involving multiple genes and pathways and therefore too complicated to mimic with crude genetic engineering techniques (see [89] Genetic Modification Trails Conventional Breeding By Far, *SiS* 64).

Regulatory science corrupt, ban glyphosate locally

Glyphosate re-assessment by the EU commission was performed in 2014, not only re-approving glyphosate, but approving increased residue levels for food and feed, with the final decision expected in 2015. The reassessment was performed by industry, though Germany acted as the rapporteur state, submitting the renewal assessment report to the European Food Safety Authority (EFSA) (see [90] Scandal of Glyphosate Re-assessment in Europe (*SiS* 63). This report relied on summary assessments provided by the Glyphosate Task Force which consists of Monsanto and other chemical companies such as Syngenta UK and Dow Italy. Assessments were made on glyphosate excluding commercial formulations most frequently used such as Roundup, and focused on studies showing less toxic results.

It has been well-documented and previously explained in Ban GMOS Now [73], that adjuvants present in glyphosate formulation products such as POEA, as well as glyphosate metabolites like AMPA have their own toxicity and moreover, that glyphosate and the adjuvants together are far more toxic than glyphosate alone. A new 2014 study by Professor Séralini's group further confirms this, showing for the first time that glyphosate formulation products (as well as insecticide and fungicides) are far more toxic than glyphosate alone at concentrations well below agricultural dilutions [91]. Using human cell lines (HEK293, JEG3 and HepG2), they showed formulations to cause significant reductions in cell viability at concentrations 125 times less than glyphosate alone, challenging the relevance of the current acceptable daily intake (ADI). It is important to note that studies on the effects of pesticide cocktail mixtures, a far more likely scenario in real life, have yet to be properly investigated.

To conclude

The evidence of glyphosate toxicity to both human and animal health and the ecosystem has built up to such an extent that some governments are taking action. As mentioned earlier, both El Salvador and Sri Lanka have made steps towards banning the herbicide. The Netherlands successfully banned its sale to private individuals [92]. Russia has recently decided to ban the import and cultivation of all GM crops due to health and environmental concerns [93], while a section of the Chinese army has reportedly banned its consumption [94]. In Brazil a public prosecutor is also looking to suspend its use [95].

For those of us who are not being protected by our governments, it is time to start initiating our own campaigns, banning it first from our home, our community, our schools, local counties, regions.

References

1. Dock Fon TA, Uhing EH, "Aminomethylenephosphinic acids, salts thereof, and process for their production", U.S. Patent No. 3,160,632, 8 Dec 1964.
2. Franz J. N-phosphonomethyl-glycine phytotoxicant compositions. U.S Patent No. 3799758 A, 26th March 1974.
3. Glyphosate in your bread and cereal bars. GMWatch.org, 01st January 2014 http://www.gmwatch.org/index.php/news/archive/2014/15232-glyphosate-in-your-bread-and-cereal-bars
4. Problems with glyphosate overuse and alternatives for farmers. Friends of the Earth report 2013 http://www.foeeurope.org/sites/default/files/press_releases/foee_6_problems_with_glyphosate_overuse.pdf
5. Huber D. Failed Promises; Flawed Science: Interactions of Glyphosate and GMOs on Soil, Plant, Animal & Human Health. Oral Presentation, UK Houses of Parliament, 18th Junes 2014. http://agroecology-appg.org/ourwork/rounding-up-glyphosate-is-it-really-safe/
6. Ávila-Vázquez, M. Using Glyphosate with GMO Seeds in Argentina. Science in Society, to appear.
7. Alonso LL, Ronco, AE, Marino DJ. C15 - NIVELES DE GLIFOSATO Y ATRAZINA EN AGUAS DE LLUVIA DE LA REGIÓN PAMPEANA. V° Congreso Argentino, Sociedad de Toxicología y Químics Ambiental. 2014 http://congresosetacnqn.com.ar/stc/images/archivos/LibroResumenes_SETAC2014.pdf
8. Battaglin WA, Meyer MT, Kuivila KM, and Dietze JE. Glyphosate and Its Degradation Product AMPA Occur Frequently and Widely in U.S. Soils, Surface Water, Groundwater, and Precipitation. *Journal of the American Water Resources Association (JAWRA)* 2014, 50, 275-290. DOI: 10.1111/jawr.12159
9. Sanchís J, Kantiani L, Llorca M, Rubio F, Ginebreda A, Fraile J, Garrido T, Farré M. Determination of glyphosate in ground water samples using an ultrasensitive immunoassay and confirmation by on-line solid-phase extraction followed by liquid chromatography coupled to tandem mass spectrometry. *Analytical and Bioanalytical Chemistry*2012, 402, 2335-45.
10. Mason, R. How Roundup Poisoned My Nature Reserve, Science in Society 64 , 19-23, 2014
11. Ban glyphosate, environmentalists tell Hackney Council at campaign launch. Hackney Citizen, hackneycitizen.co.uk, accessed 22nd December 2014.
12. Mercurio P, Flores F, Mueller JF, Carter S, Negri AP. Glyphosate persistence in seawater. *Marine Pollution Bulletin* 2014, 85, 385-90.
13. BUND, FoE. Determination of Glyphosate residues in human urine samples from 18 European countries. Friends of The Earth Report, 2013 https://www.foeeurope.org/sites/default/files/glyphosate_studyresults_june12.pdf
14. Glyphosate Testing Full Report: Findings in American Mothers' Breast Milk, Urine and Water. MomsAcrossAmerica.com, 2014. http://www.momsacrossamerica.com/glyphosate_testing_results
15. Krüger M, Schrödl W, Neuhaus J, Shehata AA. Field Investigations of Glyphosate in Urine of Danish Dairy Cows. *J Environ Anal Toxicol* 2014, 186. doi: 10.4172/2161-0525.1000186

16. Glyphosate Found in Feeding Tube Liquid. MomsAcrossAmerica.com, 2014. http://www.momsacrossamerica.com/glyphosate_found_in_feeding_tube_liquid
17. Sirinathsinghji E. Pesticide Illnesses and GM Soybeans. Ban on Aerial Spraying Demanded in Argentina. Science in Society 53, 42-43, 2012
18. Report from the 1st National Meeting of Physicians in the Crop-sprayed Towns, Faculty of Medical Sciences, National University of Cordoba, 27th and 28th August 2010 http://www.reduas.fcm.unc.edu.ar/wp-content/plugins/download-monitor/download.php?id=34
19. Glyphosate, Brain Damaged Babies, and Yakima Valley – A River Runs Through It. Farmwars.info http://farmwars.info/?p=11137
20. Ho. Glyphosate/Roundup & Male Infertility, Science in Society 62, 14-17.
21. Antoniou M, Habib M, Howard CV, Jennings RC, Leifert C, Nodari RO, Robinson C, Fagan J. Roundup and birth defects: Is the public being kept in the dark? *Earth Open Source*, 2011.
22. Sirinathsinghji E and Ho MW. EU Regulators and Monsanto Exposed for Hiding Glyphosate Toxicity.Science in Society 51, 46-48, 2011
23. Ho MW. Lab study establishes glyphosate link to birth defects. Science in Society 48, 32-33, 2010
24. Paganelli A, Gnazzo V, Acosta H, Lopez SL and Carrasco AD. Glyphosate-based herbicides produce teratogenic effects on vertebrates by impairing retinoic acid signalling. Chem Res Toxicol, August 9. http://pubs.acs.org/doi/abs/10.1021/tx1001749
25. Schreinemachers DM. Birth malformations and other adverse perinatal outcomes in four U.S. Wheat-producing states. *Environ Health Perspect.* 2003, 111, 1259-64.
26. Winchester PD, Huskins J, Ying J. Agrichemicals in surface water and birth defects in the United States. *Acta Paediatr* 2009, 98, 664-9.
27. Settimi L, Spinelli A, Lauria L, Miceli G, Pupp N, Angotzi G et al. 2008. Spontaneous abortion and maternal work in greenhouses. *Am J Ind Med* 51, 290-295
28. Howe CM, Berrill M, Pauli BD, Helbing CC, Werry K, Veldhoen N. Toxicity of glyphosate-based pesticides to four North American frog species. *Environmental Toxicology and Chemistry* 2004, 23, 1928-38.
29. Soso AB, Barcellos LJ, Ranzani-Paiva MJ, Kreutz LC, Quevedo RM, Anziliero D, Lima M, Silva LB, Ritter F, Bedin AC, Finco JA. Chronic exposure to sub-lethal concentration of a glyphosate-based herbicide alters hormone profiles and affects reproduction of female Jundiá (Rhamdia quelen). *Environmental Toxicology and Pharmacology* 2007, 23, 308-13
30. WHO (World Health Organization). 1994. Glyphosate. *Environmental Health Criteria*. 159. http://www.inchem.org/documents/ehc/ehc/ehc159.htm#SectionNumber:7.3
31. Romano MA, Romano RM, Santos LD, Wisniewski P, Campos DA, de Souza PB, Viau P, Bernardi MM, Nunes MT, de Oliveira CA. Glyphosate impairs male offspring reproductive development by disrupting gonadotropin expression. *Archives of Toxicology* 2011, Nov 26.
32. Pedersen IB. Changing from GMO soy to Non-GMO Natural Soy, Experiences from Denmark, Science in Society 64, 8-12.

33. Mañas F, Peralta L, Raviolo J, Ovando HG, Weyers A, Ugnia L, Cid MG, Larripa I, Gorla N. Genotoxicity of glyphosate assessed by the comet assay and cytogenetic tests. *Environ Toxicol Pharmacol* 2009, 28, 37-41. doi: 10.1016/j.etap.2009.02.001.
34. Simoniello MF1, Kleinsorge EC, Scagnetti JA, Mastandrea C, Grigolato RA, Paonessa AM, Carballo MA. Biomarkers of cellular reaction to pesticide exposure in a rural population. *Biomarkers* 2010, 15, 52-60. doi: 10.3109/13547500903276378.
35. Lopez SL, Aiassa D, Stella Benıtez-Leite S, Lajmanovich R, Mañas F, Poletta G, Sanchez N, Simoniello MF, Carrasco AE. Pesticides Used in South American GMO-Based Agriculture: A Review of Their Effects on Humans and Animal Models. *Advances in Molecular Toxicology, Vol. 6* Amsterdam: The Netherlands, 2012, pp. 41-75
36. Marc J, Mulner-Lorillon O, Bellé R. Glyphosate-based pesticides affect cell cycle regulation. *Biol Cell* 2004, 96, 245-9.
37. Bellé R, Le Bouffant R, Morales J, Cosson B, Cormier P, Mulner-Lorillon O. Sea urchin embryo, DNA-damaged cell cycle checkpoint and the mechanisms initiating cancer development. *J Soc Biol* 2007, 201, 317-27.
38. Guilherme S, Santos M, Gaivão I, Pacheco M. DNA and chromosomal damage induced in fish (*Anguilla anguilla L.)* by aminomethylphosphonic acid (AMPA)-the major environmental breakdown product of glyphosate. *Environ Sci Pollut Res* 2014. DOI 10.1007/s11356-014-2803-1
39. Ho MW. Glyphosate and Cancer. Science in Society 62, 12-13, 2014.
40. Thongprakaisang S,Thiantanawat A,Rangkadilok N, Suriyo T,Satayavivad J. Glyphosate induces human breast cancer cells growth via estrogen receptors. *Food Chem Toxicol.*2013, 59C, 129-136 http://www.ncbi.nlm.nih.gov/pubmed/23756170
41. Walsh LP, McCormick C, Martin C, Stocco DM. Roundup inhibits steroidogenesis by disrupting steroidogenic acute regulatory (StAR) protein expression. *Environmental Health Perspectives* 2000, 108, 769-76.
42. Clair E, Mesnage R, Travert C, Séralini GE. A glyphosate-based herbicide induces necrosis and apoptosis in mature rat testicular cells in vitro, and testosterone decrease at lower levels. *Toxicology In Vitro* 2011 Dec 19. [Epub ahead of print]
43. Hardell L, Eriksson M, Nordstrom M. Exposure to pesticides as risk factor for non-Hodgkin's lymphoma and hairy cell leukemia: pooled analysis of two Swedish case-control studies. *Leuk Lymphoma* 2002, 43, 1043-9
44. De Roos AJ, Zahm SH, Cantor KP, Weisenburger DD, Holmes FF, Burmeister LF, Blair A. Integrative assessment of multiple pesticides as risk factors for non-Hodgkin's lymphoma among men. *Occup Environ Med* 2003, 60, E11.
45. Eriksson M, Hardell L, Carlberg M, Akerman M. Pesticide exposure as risk factor for non-Hodgkin lymphoma including histopathological subgroup analysis. *Int J Cancer* 2008, 123, 1657-63.
46. Cancer deaths double where GM crops and agro-chemicals used. GMWatch.org, 24th June 2014 http://www.gmwatch.org/index.php/news/archive/2014/15506-cancer-deaths-double-where-gm-crops-and-agro-chemicals-used
47. Schinasi, Leah Leon, Maria E. Non-Hodgkin lymphoma and occupational exposure to agricultural pesticide chemical groups and active ingredients: a systematic review and meta-analysis. *Int. J. Environ. Res. Public Health* 2014, 11, 4449-4527; doi:10.3390/ijerph110404449

48. Séralini G-E, Clair E, Mesnage R, Gress S, Defarge N, Malatesta M, Hennequin D, de Vendômois J-S. Long term toxicity of a Roundup herbicide and a Roundup-tolerant genetically modified maize. *Food and Chemical Toxicology* 2012. Retracted http://dx.doi.org/10.1016/j.fct.2012.08.005
49. Ho MW and Saunders PT. Retracting Séralini study violates science & ethics. Science in Society 61, 20-21, 2014.
50. Séralini G-E, Clair E, Mesnage R, Gress S, Defarge N, Malatesta M, Hennequin D, de Vendômois J-S. Re-published: Long term toxicity of a Roundup herbicide and a Roundup-tolerant genetically modified maize *Environmental Sciences Europe* 2014, 26, 14 http://www.enveurope.com/content/26/1/14
51. Becker HA, Clark EA, Cummins J, Davidson RM, de Guzman LE, DelGiudice E, Dotson RS, Exley C, Haffegee J, Ho MW, Huber DM, John B, Mason R, Mendoza T, Novotny E, Oller JW, Palmer J, Pollack G, Pusztai A, Samsell A, Saunders PT, Shiva V, Sirinathsinghji, E, Swanson N, Seneff S, Tomlijenovic L, Zamora O. Open letter on retraction and pledge to boycott Elsevier. Science in Society 61, 17, 2014.
52. Séralini G-E, Mesnage R, Clair E, Gress S,Vendômois J, Cellier D. Genetically modified crops safety assessments: present limits and possible improvements. 2011. *Environmental Sciences Europe*, 23, 10-20
53. Benachour N and Séralini G-E. Glyphosate formulations Induce Apoptosis and Necrosis in Human Umbilical, Embryonic, and Placental Cells. *Chem. Res. Toxicol.* , 2009, 22 (1), pp 97–105
54. Sirinathsinghji E. GM Feed Toxic, Meta-Analysis Reveals. *Science in Society* 52, 30-32, 2011.
55. Ho MW and Cherry B. Death by multiple poisoning, glyphosate and Roundup. *Science in Society* 42, 14, 2009.
56. Jayasumana C Gunatilake S, Senanayake P. Glyphosate, Hard Water and Nephrotoxic Metals: Are They the Culprits Behind the Epidemic of Chronic Kidney Disease of Unknown Etiology in Sri Lanka? *Int. J. Environ. Res. Public Health* 2014, 11, 2125-2147; doi:10.3390/ijerph110202125
57. Sirinathsinghji E. Sri Lanka Partially Bans Glyphosate for Deadly Kidney Disease Epidemic. Science in Society 62, 18-21, 2014.
58. South American Illness Baffles Scientists as Workers Succumb to Kidney Failure.DailyMail.com, accessed 2th June 2014. http://www.dailymail.co.uk/news/article-2100079/South-American-illness-baffles-scientists-workers-succumb-kidney-failure-rates-unseen-anywhere.html
59. New urgency targets mysterious kidney disease in Central America. Publicintegrity.org, accessed 25th June 2014 http://www.publicintegrity.org/2013/04/29/12582/new-urgency-targets-mysterious-kidney-disease-central-america
60. Rodloff AC and Krüger M. Chronic *Clostridium botulinum* infections in farmers. *Anaerobe* 2012, 18, 226-8.
61. Ackermann W, Coenen M, Schrödl W, Shehata AA, Krüger M. The Influence of Glyphosate on the Microbiota and Production of Botulinum Neurotoxin During Ruminal Fermentation. *Current Microbiology* 2014 Nov 19. [Epub ahead of print]
62. Swanson NL, Leu A, Abrahamson J, Wallet B. Genetically Engineered Crops, Glyphosate and the Deterioration of Health in the United States of America. *Journal of Organic Systems* 2014, 9, 2.

63. Moms Across America Testimonials. MomsAcrossAmerica.com http://www.momsacrossamerica.com/zenhoneycutt/mom_s_testimonials
64. Shehata AA, Schrödl W, Aldin AA, Hafez HM, Krüger M. The effect of glyphosate on potential pathogens and beneficial members of poultry microbiota in vitro. *Current Microbiology* 2013, 66, 350–358.
65. Carman JA, Vlieger HR, Ver Steeg LJ, Sneller VE, Robinson GW, Clinch-Jones CA, Haynes JI, Edwards JW. A long-term toxicology study on pigs fed a combined genetically modified (GM) soy and GM maize diet. *Journal of Organic Systems* 2013, 8, 38–54
66. Gerlach H, Gerlach A, Schrödl W, Schottdorf B, Haufe S, Helm H, Shehata A. Oral Application of Charcoal and Humic acids to Dairy Cows Influences *Clostridium botulinum* Blood Serum Antibody Level and Glyphosate Excretion in Urine. *J Clin Toxicol* 2014, 4, 186. doi: 10.4172/2161-0495.186
67. Saunders P. Marked Deterioration of Public Health Parallels Increase in GM Crops and Glyphosate Use, US Government Data Show. Science in Society 65, to appear.
68. Gress S1, Lemoine S, Puddu PE, Séralini GE, Rouet R. Cardiotoxic Electrophysiological Effects of the Herbicide Roundup® in Rat and Rabbit Ventricular Myocardium In Vitro. *Cardiovasc Toxicol* 2014 Dec 2. [Epub ahead of print]
69. Samsel A and Seneff S. Glyphosate's suppression of cytochrome P450 enzymes and amino acid biowynthesis by gut microbiome: pathways to modern diseases. *Entropy* 2013, 15, 1-x manuscripts; doi: 19.3390/e140x000x.
70. Seneff S, Swanson N, Li C. Aluminum and Glyphosate Can Synergistically Induce Pineal Gland Pathology: Connection to Gut Dysbiosis and Neurological Disease. *Agricultural Sciences* 2016, 6. http://www.scirp.org/journal/PaperInformation.aspx?paperID=53106&#.VLVXYCusXVI
71. WeedScience Database, International Survey of Herbicide Resistant Weeds. http://www.weedscience.org/In.asp, accessed 19th November 2014
72. GM Soy Loses its Appeal for Latin American Farmers. GMWatch.com, accessed 25yth June 2014. http://gmwatch.org/index.php/news/archive/2014/15486-gm-soy-loses-its-appeal-for-latin-american-farmers
73. Ho MW & Sirinathsinghji E. *Ban GMOs* Now. *Health and Environmental Hazards Especially in Light of the New Genetics*. ISIS Special Report, 2013.http://www.i-sis.org.uk/Ban_GMOs_Now.php
74. Cuhra M, Traavik T, Boh T. Clone- and age-dependent toxicity of glyphosate commercial formulation and its active ingredient in Daphnia magna. *Ecotoxicity* 2012, 22, 251-62
75. Ho MW. Roundup kills grogs Science in Society 26. 13, 2005.
76. Kremer RJ and Means NE. Glyphosate and glyphosate-resistant crop interactions with rhizosphere microorganisms. *European Journal of* Agronomy 2009, 31, 153-6.
77. Ho MW. Roundup Kills Frogs. Science in Society 26, 14, 2005
78. Santadino M, Coviella C, Momo, F. Glyphosate Sublethal Effects on the Population Dynamics of the Earthworm *Eisenia fetida* (Savigny, 1826). *Water, Air, & Soil Pollution* 2014, 225, 2207
79. Sirinathsinghji E. Glyphosate & Monarch Butterfly Decline. Science in Society 52, 32-33, 2011

80. Pleasants JM & Oberhauser KS. Milkweed loss in agricultural fields because of herbicide use: effect on the monarch butterfly population.*Insect Conservation and Diversity* 2012, doi: 10.1111/j.1752-4598.2012.00196.x
81. Over 200 Groups, Businesses, and Leading Scientists Call for Monarch Protection. BeyondPesticides.org, November 14th 2014. http://www.beyondpesticides.org/dailynewsblog/?p=14491
82. Sirinathsinghji E. USDA Scientist Reveals All. Glyphosate Hazards to Crops, Soils, Animals and Consumers. Science in Society 53, 36-39, 2012
83. McLaren PJ, Cave JG, Parker EM, Slocombe RF. Chondrodysplastic calves in Northeast Victoria. *Veterinary Pathology* 2007, 44, 342-54
84. Animal Health issues related to glyphosate and Roundup Ready GMO crops and feed. An Open Letter from Dr Art Dunham DVM, ISU 1974. (Dairy, beef and swine practitioner in the USA since 1974.) GMFreeCymru.org.uk. http://www.gmfreecymru.org.uk/open_letters/Open_letter02Sept2013.html
85. Ho MW. Global Status of GMO and non-GMO Crops. Science in Society 62, 2-5, 2014.
86. Ag experts helping farmers switch to non-GMO, sustainable production. Non-GMOreport.com 28th April 2014. http://www.non-gmoreport.com/articles/may2014/ag-experts-helping-farmers-switch-to-non-GMO-sustainable-production.php#sthash.kpo9S7Ka.dpuf
87. Sirinathsinghji E. GM Crops and Water – A Recipe for Disaster. Science in Society 58, 8-10, 2013.
88. Sirinathsinghji E. GM Crops Destroyed by US Drought but non-GM Varieties Flourish. Science in Society 56, 6-8, 2012
89. Saunders P. Genetic Modification Trails Conventional Breeding By Far. Science in Society 64, 2-4, 2014.
90. Swanson N and Ho MW. Scandal of glyphosate reassessment in Europe. Science in Society 63, 8-9, 2014. http://www.i-sis.org.uk/Scandal_of_Glyphosate_Reassessment_in_Europe.php
91. Schledorn P, Krüger M Mesnage R, Defarge N, Spiroux de Vendômois J, Séralini, GE. Major pesticides are more toxic to human cells than their declared active principles. *BioMed Research International Volume* 2014, Article ID 179691, 1-8 http://dx.doi.org/10.1155/2014/179691
92. Dutch Parliament Bans Glyphosate Herbicides for non-Commercial Use. SustainablePulse.com, accessed 25th June 2014. http://sustainablepulse.com/2014/04/04/dutch-parliament-bans-glyphosate-herbicides-non-commercial-use/#.U6n-SPldXTE
93. Russia bans Import and Production of GMO Food, tightens Non-Food GMO Restrictions. NSNBC.me, accessed 25th June 2014 http://nsnbc.me/2014/04/06/russia-bans-import-production-gmo-food-tightens-non-food-gmo-restrictions/
94. Chinese Army Bans All GMO Grains and Oil from Supply Stations. Sustainablepulse.com, accessed 25th June 2014. http://sustainablepulse.com/2014/05/14/chinese-army-bans-gmo-grains-oil-supply-stations/#.U6sIHfldXTE

95. Brazil Seeks Ban on Monsanto Herbicide Due to Alarming Toxicity Risks. EcoWatch, 27th March 2014. http://ecowatch.com/2014/03/27/brazil-ban-monsanto-herbicide-toxic/