provide robust statistics on the reliability of the results, which is a key strength of the study.

Note that the authors' definition of what constitutes a delta is broad (see the Methods section of the paper for the criteria used), which means that their model is truly global. However, the model's ability to capture the general behaviour of all deltas comes at the expense of fine-grained accuracy — there will almost inevitably be errors in the morphologies projected for some individual deltas. Nevertheless, the model's results are statistically valid at a global level.

Nienhuis and colleagues used their model to estimate the effects of upstream human interventions on delta morphology during the period 1985–2015. They found that dam building led to decreases in sediment delivery, whereas accelerated soil erosion caused by deforestation increased sediment delivery. Of the approximately 11,000 deltas analysed, about 9% are significantly affected by reduced sediment delivery, producing a total land loss of 127 square kilometres per year, whereas about 14% received increased sediment, causing a total gain of 181 $km^2\ yr^{-1}$ during the study period. The reason more deltas have experienced an increase in sediment delivery, rather than a decrease, is simply that the effects of massive deforestation have outpaced sediment trapping by dams.

Previously reported state-of-the-art studies[2,3] of global coastal morphology involved the computationally intensive analysis of extremely large archives of satellite images, which have become available in the past few years. These studies also revealed a net increase in land surface area. Many of the land gains could be explained by large-scale phenomena, such as the disappearance of the Aral Sea in central Asia, and by extensive land-reclamation projects along the China coast. But beyond those special cases, it is also crucial to learn in greater detail where and why river deltas have gained or lost land across the globe. Nienhuis *et al.* fill in this key part of the puzzle.

The new study also reveals notable regional patterns. For example, arctic river deltas have seen almost no change in morphology. Sediment delivery by rivers in North America has fallen overall, leading to large land losses — in the Mississippi delta, for example. And the largest land gains are in eastern South America and in south, southeast and east Asia, where soil erosion due to deforestation has caused a net growth in delta areas, despite the construction of sizeable dams in these regions.

Large deltas, such as those of the Niger, Huang He and Mekong, have great socio-economic value. Such densely inhabited deltas typically experience many pressures in addition to changes in sediment delivery, such as stresses associated with groundwater pumping, sand mining, dyke construction and loss of biodiversity[4–6]. For these highly complex deltaic systems, local studies will be needed to assess the problems that adversely affect their morphology and to define specific solutions[6]. However, most of the deltas considered by Nienhuis and co-workers are much smaller. This could skew the picture painted by the overall numerical results, because large deltas have a much greater global impact than do small ones, but represent a tiny fraction of the total number of deltas analysed in the study. For example, the study calculates that the net land gain for all deltas was 54 $km^2\ yr^{-1}$ during the period studied, which seems like good news. But this area is tiny compared with the 105,000 km^2 covered by the Ganges delta alone (Fig. 1) — which, with its population of 170 million people, is subject to a multitude of stresses[7]. We should therefore not be complacent about the new findings.

Nienhuis *et al.* did not include sea-level rise in their model, but sea levels rose by about 10 cm over the period studied (see go.nature.com/2tpjpxg). This will probably not have produced observable losses of delta land, given the large spatial variability of sea-level rises. Nevertheless, it would be interesting to see whether measurable losses did occur. The authors' model provides a useful description of the background dynamics of changes in delta morphology against which the impact of rising seas can be measured once sea levels approach predicted increases of 60 cm (ref. 8) or more[9], as a result of global warming. Severe sea-level rise will undoubtedly cause coastline recession in deltas, as it has in the geological past[10].

Validated global models describing key parts of the Earth system are crucial in this time of unprecedented human-induced climate change. Deltas connect the terrestrial and maritime branches of the hydrological cycle and the associated sediment fluxes. As such, they encapsulate many key indicators of global change. By accounting for the baseline effects on deltas of human activities such as dam building and deforestation, Nienhuis and colleagues have provided a fundamental framework that will help assessments of the impacts of climate change for decades to come.

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Cancer immunology

B cells to the forefront of immunotherapy

Tullia C. Bruno

Three studies reveal that the presence in tumours of two key immune components — B cells and tertiary lymphoid structures — is associated with favourable outcomes when individuals undergo immunotherapy. **See p.549, p.556 & p.561**

Current immunotherapies aim to reinvigorate immune cells called killer T cells to fight cancer, but only 20% of individuals with the disease see a lasting clinical benefit from this type of treatment[1]. Focusing on other immune cells in patients' tumours might help us to improve these outcomes. Three studies, by Cabrita *et al.*[2] (page 561), Petitprez *et al.*[3] (page 556) and Helmink *et al.*[4] (page 549), now demonstrate that the presence of B cells in human tumours in compartments called tertiary lymphoid structures (TLS) is associated with a favourable response to immunotherapy. These complementary studies add to the immunotherapy toolbox by providing new ways of predicting prognosis.

The presence of B cells in tumours has been considered to be a predictor of increased patient survival[5,6], but there are reports of both anti- and pro-tumour roles for B cells[7].

These differing reports reflect the multiple roles that B cells can have in tumours. One component of the antitumour function of B cells is B-cell activation. This process involves the binding of tumour-derived proteins to the B-cell receptor protein on the cell surface and the subsequent processing of these tumour-derived proteins into smaller fragments called antigens. Further co-factors are also involved in activation. Activated B cells can release antibodies that tag tumour cells for attack by other cellular players of the immune system (a process known as antibody-dependent cell death)[8], and can 'educate' T cells by presenting them with tumour antigens, enabling the T cells to target tumour cells effectively[9]. However, B cells in tumours can produce inhibitory factors that hinder the function of immune cells (Fig. 1). These might be signalling molecules that suppress the immune system[7,10,11] or inhibitory molecules on the surfaces of B cells that limit the body's ability to target and kill tumour cells.

TLS are aggregates of immune cells (mostly T and B cells) that arise in response to immunological stimuli. Mature TLS nurture B-cell development and function in an inner region of the structure called the germinal centre, whereas immature TLS do not contain proper germinal centres, and might not nurture full B-cell function. The presence of TLS in a tumour also correlates with increased patient survival in many cancer types[12]. The three current studies confirm this trend in the context of immunotherapy, demonstrating that infiltration of B cells into a tumour, along with the presence of TLS, is associated with an improved response to this type of treatment.

Cabrita *et al.* studied individuals who had a type of cancer called metastatic melanoma, and Petitprez *et al.* investigated people with sarcoma, a cancer of the bone. Both teams found that the presence of B cells in TLS in the tumour before treatment was associated with an increased chance that patients' tumours would respond to immunotherapy. Helmink *et al.* corroborated these findings for metastatic melanoma, and reported the same pretreatment trend in renal cell carcinoma. These authors also demonstrated that, during treatment, TLS are more prevalent in people who have tumours that are responding to treatment than in those whose tumours are not. This timing is important – when present before treatment, TLS could be considered a predictor of patient response to immunotherapy, whereas the presence of TLS during treatment indicates that key combinations of immune cells are being manipulated to induce TLS formation. Identifying these cell combinations could help in establishing new and effective immune-based therapies.

The three groups found that the B-cell and TLS signature was often more pronounced in responders than in non-responders. Furthermore, the signature was more prominent than typical T-cell signatures currently used for understanding immunotherapy outcomes. This suggests that B cells and TLS could have a key role in antitumour immunity.

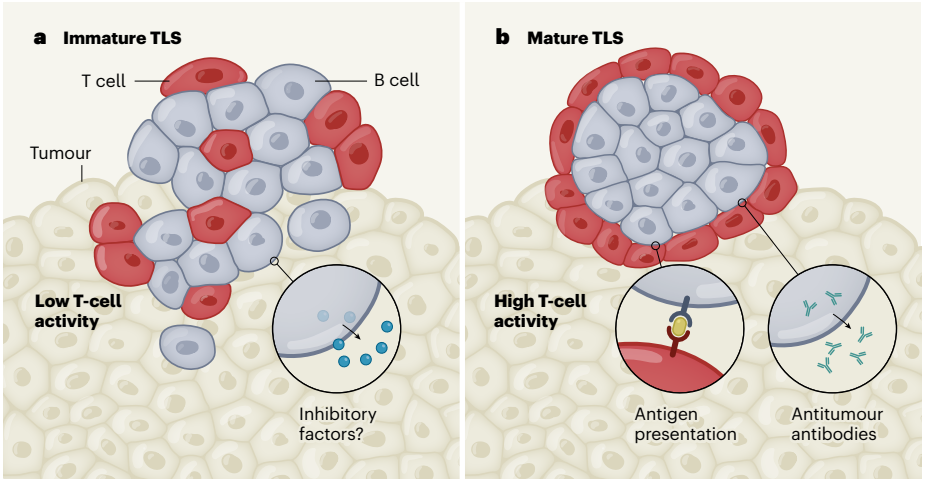

Figure 1 | Multifaceted B cells in the tumour microenvironment. B cells are thought to have multiple roles in suppressing or promoting the immune system's ability to kill tumour cells, depending on whether they are located in immature or mature compartments called tertiary lymphoid structures (TLS), which also contain T cells. **a**, In poorly structured, immature TLS, one hypothesis is that B cells generate inhibitory factors. These might be molecules released from B cells that dampen the response of other immune cells, or molecules on the surfaces of B cells that hinder the targeting and destruction of tumour cells. Both of these inhibitory mechanisms might arise if B cells have less interaction with T cells and more interaction with the malignant tumour. Three studies[2–4] now provide indirect evidence that immature TLS are associated with low activity of T cells in tumours. **b**, By contrast, B cells in well-structured, mature TLS can release antibodies that could target tumours, and B cells can present a tumour-derived protein called an antigen (yellow) to T cells in the tumour, activating the T cells. The studies suggest that the presence of B cells in mature TLS is correlated with increased T-cell activity, improving the immune system's ability to target tumour cells, and increasing the likelihood that the tumour will respond to immunotherapy.

In addition to these synergistic results, each study highlights a unique role for B cells or TLS in antitumour immunity. First, Cabrita *et al.* demonstrate that B cells in TLS synergize with killer T cells that could ultimately target tumour cells. Second, Petitprez *et al.* describe signatures characteristic of mature TLS in sarcoma. This implies that mature TLS can exist in tumour sites that are not normally thought to be infiltrated by immune cells, a phenomenon that has not previously been shown. Third, Helmink *et al.* find increased diversity of B-cell receptors in responders compared with non-responders. This indicates that pools of B cells in responders might have a greater ability to specifically recognize tumour antigens than do the B cells of non-responders.

These papers are technologically savvy, use patient populations that are statistically robust and bring B cells and TLS to the forefront of antitumour immunity. However, there is much still to learn. First, more emphasis should be placed on understanding how TLS form in tumours. It is clear that these structures are variable, and can be immature or mature. What does this diversity mean for the function of B cells in TLS, and what causes the induction of one 'flavour' of TLS versus another? The contribution of environmental factors such as smoking or viral and bacterial infections should be considered, along with a person's gender, age and tumour type.

Researchers should also ask whether mature TLS could be routinely induced to form in tumours, to maximize B-cell immunity. Addressing this issue will require investigation of B cells and TLS in individuals who have not yet undergone treatment, as well as proper modelling of the human tumour microenvironment. Current evidence indicates that B cells actually impede antitumour responses in most mouse models of cancer[13–15]. However, TLS formation is rare in these animals, and a lack of TLS might alter the fate and subsequent function of B cells. Indeed, more knowledge about B-cell function outside TLS is needed to provide a complete picture of B cells in the tumour microenvironment.

There is still a need to define the full range of functions that B cells perform in tumours. In addition to their known roles in producing tumour-specific antibodies and presenting antigens[8,9], B cells are likely to have other functions – for instance, inducing antibody-dependent cell death[8]. It will also be necessary to link these functions to specific B-cell types and to determine whether such cells are found inside or outside TLS. There are clear biomarkers for B-cell subsets, but linking these subsets to functions in human tumours would allow us to design treatments

that optimize specific antitumour activities. Furthermore, this knowledge would help us to understand whether subsets of B cells perform separate tasks, or if there is crosstalk between subsets. For example, can the same B cell both produce a tumour-specific antibody and present antigens to T cells? Some of these studies can be done in human tumours, but in-depth mechanistic studies will require physiologically relevant models that contain naturally occurring TLS.

With regard to clinical implications, the current studies suggest that therapeutics to enhance B-cell responses should be prioritized as a complement to T-cell-mediated immunotherapies. Researchers should now ask whether B cells could be engineered to target specific tumour antigens, similar to current efforts to engineer antigen-targeting T cells. More generally, could immunotherapies be improved by inducing B cells to form in TLS after a person has received T-cell-based immunotherapy?

Overall, the current studies should act as a springboard for future mechanistic studies of B cells and TLS in cancer. Understanding how current therapies can be combined with approaches to harness B cells and TLS will be crucial for the development of effective B-cell-specific immunotherapies.

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WALTER STEIN/GETTY

Invasive plants versus herbivores

The population of large animals in the Gorongosa National Park collapsed during the Mozambican civil war (1977–92), and led to encroachment of the invasive shrub *Mimosa pigra*. Writing in *Nature Ecology & Evolution*, Guyton *et al.* report that Gorongosa's repopulation with large herbivores has reduced the abundance of mimosa to pre-war levels (J. A. Guyton *et al. Nature Ecol. Evol.* http://doi.org/djff; 2020).

By analysing faecal samples from Gorongosa's five main ruminant herbivores, including waterbuck (*Kobus ellipsiprymnus*; pictured), the authors found that mimosa was the main component of the diets of these species in 2013–18. They also found that the shrub's density and biomass were greater in fenced enclosures that excluded herbivores than in unfenced areas.

The authors therefore conclude that the burgeoning populations of native large herbivores are consuming mimosa, and have thereby conferred resistance to its invasion in just ten years. The findings suggest that rewilding is a potentially useful strategy for reversing a common form of environmental degradation in Africa's protected areas. **Andrew Mitchinson**

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