

Can restoring the water cycle cool land and climate? Scientific basis and property-scale assessment using the EcoDynamics Diagnostic Engine

A working water cycle cools the land. Where soil takes in and holds rain and plants keep transpiring, more of the sun's energy is carried away as latent heat in water vapour, leaving less to heat the surface and air directly. The soil microbiologist Walter Jehne places this process within a wider account connecting soil structure, water and climate. This paper brings his framework together, reviews the evidence and describes how the EcoDynamics Diagnostic Engine (EDDE) assesses cooling at property scale. At a case-study property in South West England, local surface cooling is measurable. Cooling and carbon uptake also track the Land Health Score across the assessed fields, consistent with their shared dependence on vegetation function. A planetary cooling effect remains unproven. These findings provide a starting point for EDDE's investigation of that larger question.

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Abstract

This paper examines Walter Jehne's water-cycle cooling framework and describes a property-scale assessment developed for the EcoDynamics Diagnostic Engine (EDDE). The literature provides strong evidence for local evaporative cooling and substantial evidence for moisture recycling between land and atmosphere. The net temperature response also depends on surface reflectivity, water availability and other energy exchanges. Jehne's proposal that water-cycle restoration could offset global warming has not been demonstrated by the evidence reviewed here.

EDDE combines satellite surface-temperature observations with a constrained model of surface energy partitioning. It reports two indicators: an Evaporative cooling score, based on the share of available energy used in evapotranspiration, and a Local cooling contribution band, based on the temperature difference between a property and matched surrounding land. At a case-study property in South West England, the growing-season surface-temperature difference was $-0.98\text{ }^{\circ}\text{C}$ across 211 overpasses of NASA's ECOSTRESS instrument, with a 95% confidence interval for random error of -1.26 to $-0.70\text{ }^{\circ}\text{C}$. The difference was $-2.05\text{ }^{\circ}\text{C}$ for the hottest third of midday overpasses, corresponding to contribution band 8. The dormant-season difference was close to zero. Systematic uncertainty limits interpretation of the magnitude. The model estimates that transpiration accounts for about 73% of growing-season evapotranspiration.

Across approximately 450 fields on properties in the UK, Italy and South Africa, the Evaporative cooling score and estimated carbon uptake both correlate positively with the Land Health Score, as their shared dependence on vegetation function predicts. Carbon uptake shares fewer inputs with the score and shows the stronger association. These findings are consistent with the diagnostic measuring a functional property of the land and are open to further testing.

The assessment reports local surface cooling alongside carbon uptake and ecosystem condition. It does not estimate net planetary cooling or convert cooling into carbon-dioxide equivalents.

Keywords: evaporative cooling; transpiration; surface energy balance; water cycle; soil carbon sponge; Walter Jehne; land surface temperature; ECOSTRESS; albedo; moisture recycling; ecosystem condition; EcoDynamics Diagnostic Engine

Objectives

The paper has four objectives:

1. To present Walter Jehne's water-cycle cooling framework on its own terms, drawing his dispersed lectures and writing into a single overview.
2. To assess each proposed mechanism against the peer-reviewed evidence assembled here, distinguishing established findings, supported mechanisms and speculative claims.
3. To describe EDDE's working method for measuring local land-surface cooling at property scale, including its results, uncertainties and limits.
4. To use this assessment as a starting point for investigating whether water-cycle restoration can cool land and, at larger scales, the climate, and to invite wider scrutiny of that question.

Walter Jehne's work prompted the author to reconsider the role of land and water in responding to the climate emergency. The paper brings that thinking into remote sensing and geoinformatics, where it can be tested and modelled across many properties and regions. It makes confident claims at the local surface scale where the evidence supports them and identifies where the science and EDDE's data do not yet reach.

Introduction

Land can absorb similar amounts of sunlight yet reach very different temperatures. A dry, exposed surface uses relatively little energy to evaporate water, leaving more energy to warm the surface and the air above it. Where soil water is available and vegetation is active, evaporation and transpiration carry a larger share of that energy away as latent heat. The heat is released when the water vapour condenses, potentially some distance from its source.

This exchange links land condition to local temperature. Soil that admits and retains rainfall can sustain plants through dry periods; those plants, in turn, can sustain transpiration. The resulting cooling is an energy flux that varies with weather and season. It differs from carbon storage, which describes an amount held in vegetation or soil.

The Australian soil microbiologist Walter Jehne, formerly of CSIRO and founder of Healthy Soils Australia, has developed an account of these connections centred on what he calls the soil carbon sponge. His framework connects soil biology and structure to water retention, transpiration, cloud formation, rainfall and heat loss to space. It extends from local land management to the possibility of cooling the global climate.

Jehne presents this framework in public lectures, interviews and a paper prepared for a conference in Paris (Jehne, 2017a, 2017b). These sources are not peer-reviewed tests of the framework. His earlier peer-reviewed work concerns soil and mycorrhizal ecology, including plant colonisation on coastal sand dunes (Jehne and Thompson, 1981). The present review therefore treats his account as an integrated proposal and assesses its mechanisms against the wider literature.

The analysis proceeds in three parts: Jehne's framework, the evidence for its mechanisms, and EDDE's cooling assessment. Limitations and conclusions follow. The first paper in this series (Link, 2026) introduces EDDE and its approach to diagnosing ecosystem condition.

The distinction between surface cooling and net climate cooling is central to the analysis. Evapotranspiration transfers energy from the surface to the atmosphere; it does not, by itself, demonstrate a loss of energy from the Earth system. Establishing a planetary cooling effect requires an assessment of the resulting changes in radiation, clouds and atmospheric circulation. EDDE's measurements address local surface temperature and energy exchange at property scale.

Part 1. Walter Jehne's water-cycle framework

This account draws on Regenerate Earth (Jehne, 2017a), his Vermont workshop lecture (Jehne, 2017b), the interview with John Kempf, the Sustainable Design Master Class webinar, and his Groundswell 2024 contribution. It paraphrases the recorded material rather than relying on verbatim transcripts. The mechanisms below describe Jehne's argument; their evidential status is considered in Part 2.

1.1 Water, land degradation and climate

Jehne argues that disruption of the water cycle is a major cause of climatic warming and drying. In his account, land clearing, burning and cultivation have both released soil carbon and reduced the capacity of landscapes to regulate heat through water. He places the origins of this disturbance thousands of years before industrial fossil-fuel use.

His quantitative framing assigns about 95% of the planet's heat dynamics to water and less than 4% to carbon dioxide. He recognises carbon dioxide as a radiative forcing but describes its increase as a symptom of a wider ecological disturbance. These percentages are claims from his lectures and grey literature, not results adopted in this paper. The relative size of water-related energy exchanges cannot, on its own, establish the relative causes of climatic change.

This premise shapes his practical argument: restoring soil and vegetation could improve heat regulation through processes that land managers can influence directly.

1.2 The soil carbon sponge

The soil carbon sponge is Jehne's term for biologically active soil with a porous structure that allows rainfall to enter, remain in the root zone and support vegetation. Photosynthesis supplies carbon to plants and soil organisms. Roots, microbial activity and organic matter contribute to the structure through which water moves and is stored.

Jehne emphasises the water-holding benefit of additional soil carbon, arguing that each gram can support the retention of several grams of water. In his account, this storage buffers both heavy rainfall and dry periods: less water is shed rapidly as runoff, and more remains available for plants. Compaction, surface sealing and loss of biological structure weaken both functions.

Carbon restoration thus serves two purposes in his framework. It removes carbon dioxide from the atmosphere and helps rebuild the soil conditions needed to sustain the water cycle. The size of the water-storage benefit, and the extent to which it can be attributed to carbon alone, require qualification (Section 2.4).

1.3 Evaporation, transpiration and latent heat

Evaporation requires energy. Jehne uses a latent heat of vaporisation of approximately 590 calories per gram of water, or about 2.47 megajoules per kilogram, to illustrate the scale of the exchange. Energy used to turn liquid water into vapour leaves the evaporating surface as latent heat rather than directly warming the air as sensible heat.

He describes the global surface-to-atmosphere latent-heat transfer as roughly 80 W/m², around a quarter of incoming solar radiation. This is a global framing of evaporation and transpiration together; it is not a property-level measurement. His land-management argument is that vegetation with a reliable water supply can sustain this exchange through the growing season, whereas dry or sparsely vegetated land has less capacity to do so.

1.4 Surface temperature and thermal radiation

Jehne also invokes the Stefan-Boltzmann law, under which thermal emission increases with the fourth power of absolute temperature. He contrasts cool, hydrated vegetation with hot, exposed ground, using examples of green surfaces near 20 °C and bare surfaces at 60 to 70 °C. These temperatures illustrate his argument rather than define a general temperature limit for vegetation.

He argues that maintaining a cooler surface reduces the longwave radiation available for absorption by greenhouse gases. He describes this effect as substantially more powerful than changing greenhouse-gas concentrations alone, sometimes using a ratio of about ten to one. That ratio is part of his proposed interpretation; it is not used in the EDDE assessment. Lower thermal emission from a cooler surface is one term in the energy balance and does not independently establish net cooling of the climate system.

His response to the warming associated with a darker canopy is that sufficient transpiration can use the additional absorbed sunlight without a corresponding rise in surface temperature. Whether that balance produces net cooling depends on the conditions examined in Part 2.

1.5 The small water cycle

Jehne uses the term small water cycle for the return of water from land to the atmosphere and then to land as precipitation. He acknowledges the related framing developed by Kravčík and colleagues (2007). Moisture can be recycled repeatedly as air moves across a vegetated continent: rainfall supplies plants, plants transpire, and some of that moisture falls again farther downwind.

In his account, clearing vegetation interrupts this sequence. The effect extends beyond the cleared land because downwind areas lose an upwind source of atmospheric moisture. Repeated recycling allows water to support evaporative cooling at several locations, although the latent heat is released again at each condensation stage.

1.6 Clouds and biological precipitation

Jehne links vegetation to rainfall through both moisture supply and airborne particles. He argues that forests release biological particles, including ice-nucleating bacteria, that help initiate precipitation. He contrasts these with dust, smoke and combustion aerosols, which he associates with persistent haze and suppressed rainfall.

He also assigns clouds a major cooling role because they reflect sunlight before it reaches the surface. In his framework, restoring vegetation can therefore increase evaporative cooling, support rain formation and increase cloud reflectivity. He illustrates these connections with accounts of rainfall differences across vegetation boundaries and changes following reforestation.

The proposed distinction between warming haze and rain-producing biological particles is a simplified description of several interacting processes. The broader claim that biological particles from forests control a large share of continental rainfall remains to be established.

1.7 Clear skies and night-time heat loss

Jehne argues that rainfall can remove atmospheric moisture and particles, leaving clearer skies through which the surface can lose heat by longwave radiation. He proposes that persistent haze over degraded landscapes reduces this night-time cooling.

He connects this argument to rising night-time minimum temperatures and cites the grounding of aircraft over North America in 2001 as an example of how changes in cloudiness may affect the daily temperature range. These observations form part of his explanation; they do not, by themselves, isolate a hydrological cause or rule out greenhouse-gas forcing.

1.8 The biotic pump

Following Makarieva and Gorshkov, Jehne proposes that condensation over forests helps generate pressure gradients that draw moist maritime air inland. This biotic pump would connect forest transpiration, condensation and rainfall to continental atmospheric circulation.

He argues that loss of vegetation can weaken this supply and favour persistent hot, dry conditions. He extends the proposal to monsoon behaviour and large-scale restoration of degraded land. The condensation-driven circulation mechanism remains contested, as discussed in Section 2.5.

1.9 The role of carbon

Jehne treats atmospheric carbon dioxide as both a forcing to reduce and a source of material for rebuilding soil. His emphasis is on what restored carbon allows the soil to do: retain water, sustain vegetation and support the cooling mechanisms described above.

He gives immediate priority to maintaining living cover and restoring transpiration, which he argues can change local conditions within a season. Rebuilding soil carbon is a longer-term task that supports those gains. He also argues that atmospheric drawdown alone would be too slow and would be partly offset by ocean-atmosphere re-equilibration.

His broader proposal is that relatively small changes in transpiration or cloudiness could offset the planetary energy imbalance, with natural feedbacks limiting overcooling. This is a hypothesis about the integrated system. Neither that proposition nor his prioritisation of hydrological restoration over emissions mitigation follows from a measurement of local evaporative cooling.

EDDE uses a narrower accounting approach. It reports carbon and cooling separately, without treating either as a substitute for the other.

1.10 From local effects to a planetary proposal

Jehne's framework spans several spatial scales. Its local claims concern infiltration, water retention, transpiration and surface temperature. Its regional claims concern moisture recycling and rainfall. At continental scale it invokes the biotic pump and monsoon restoration. At planetary scale it proposes that widespread water-cycle restoration could reverse warming.

In his recorded discussions, Jehne acknowledges that the larger-scale quantities are not well measured and describes them as a research frontier. The framework therefore combines directly measurable local processes with less certain regional and planetary effects. Support for a local mechanism does not establish the magnitude or net sign of the full climate response.

Part 2. Evidence for the proposed mechanisms

2.1 Local evaporative cooling

The local cooling associated with evapotranspiration is well established. Satellite studies, field observations and reviews show that water availability and vegetation affect the division of surface energy between latent and sensible heat.

Bright et al. (2017) found that non-radiative processes, chiefly evapotranspiration and surface roughness, dominate the local temperature response to many land-cover and management changes. Duveiller, Hooker and Cescatti (2018) mapped the effects of vegetation transitions on surface energy exchange and showed that the resulting temperature response depends on the balance among its components. Field thermal observations by Hesslerová et al. (2013) found substantially lower daytime surface temperatures in well-watered vegetation than in drained or built areas. Huryňa and Pokorný (2016) review the role of vegetation and water in moderating surface-temperature maxima.

The effect also appears in studies of recent vegetation change. Zeng et al. (2017) estimated that greening over three decades reduced land-surface warming by about 0.09 °C, with increased evapotranspiration accounting for approximately 70% of the reduction. Li et al. (2023) found a small global effect but larger regional effects, offsetting up to about a third of regional land-surface warming in some areas.

For temperate Europe, Huang et al. (2020) reported net biophysical cooling from recent land-cover change, locally reaching about 1 °C in spring and summer in western and central Europe. These findings support the possibility of substantial evaporative cooling in the climatic setting of the case-study property. They do not imply that every vegetated property will be cooler than its neighbours.

2.2 Moisture recycling and regional rainfall

Moisture recycling is quantitatively established. Van der Ent et al. (2010) estimated that about 40% of precipitation over land originates from evaporation over land, and that 57% of land evaporation returns as precipitation over land. These exchanges occur across continents; the recycled moisture need not fall close to its source.

Keys et al. (2012) introduced the *precipitation shed*: the upwind source area whose evaporation supplies rainfall to a particular region. This approach makes it possible to examine how land-use change in one area may affect water availability elsewhere.

Ellison et al. (2017) synthesised evidence for the effects of forests on water, energy and rainfall, arguing that these functions should be considered alongside carbon storage. Sheil and Murdiyarso (2009) examined the hypothesis that forests help attract rainfall and identified the need for further testing of its mechanisms.

Millán et al. (2005) and Millán (2014) describe a regional case in the western Mediterranean, linking land-use change and reduced surface evapotranspiration to changes in summer sea-breeze storms and later extreme rainfall. This interpretation draws on observations and analysis of regional weather systems, rather than a controlled experiment. It illustrates why changes in land-atmosphere water exchange may alter the location and timing of precipitation as well as conditions at the source.

2.3 Albedo and the full surface energy balance

Albedo is the fraction of incoming sunlight reflected by a surface. A dark canopy generally absorbs more shortwave radiation than a brighter surface. Any cooling from increased evaporation must there-

fore be considered alongside the additional energy absorbed and the other changes in heat exchange.

Rotenberg and Yakir (2010) examined this balance in a semi-arid pine forest. They found warming contributions from lower albedo and reduced longwave emission that counteracted the carbon benefit; several decades of carbon uptake were needed to balance the radiative effect. They also reported efficient removal of sensible heat by convection. The study shows why local surface temperature, radiative forcing and carbon uptake cannot be treated as interchangeable measures.

Bright et al. (2017) and Schultz et al. (2017) likewise show that the response depends on location and on the processes affected. Daytime and night-time responses can differ, and the daily net effect varies with latitude and land cover. Water availability is particularly important: a darker canopy with limited transpiration may not provide a net cooling benefit.

For EDDE, this means that the albedo term must be included whenever an additional evaporative-energy contribution is presented as a net estimate. A temperature difference alone does not describe the complete radiative balance.

2.4 Soil carbon and water storage

The soil carbon sponge describes a useful connection between soil biology, structure and water. Its quantitative interpretation needs care. Water storage depends on the depth, texture and structure of the root zone as well as its organic carbon content. Infiltration, total water storage and plant-available water are related but different properties.

Minasny and McBratney (2018) found a relatively modest average increase in plant-available water capacity with additional soil organic carbon: approximately 1 mm of water per 100 mm of soil for each percentage-point increase in carbon. The effect was larger in sandy soils and smaller in fine-textured soils. Their analysis was subsequently the subject of a published comment and rejoinder.

The review supports a water-storage benefit but does not justify assigning the entire response of a restored root-zone system to carbon. Jehne's larger carbon-to-water ratios should therefore be treated as part of his framing, rather than as general coefficients for assessment.

2.5 Unresolved mechanisms and the planetary claim

The biotic-pump hypothesis was developed by Makarieva and Gorshkov (2007) and Makarieva et al. (2013). It proposes a major role for condensation-induced pressure changes in atmospheric circulation. The underlying physics remains disputed; the 2013 paper was published with an editorial note drawing attention to its controversial and unproven status. It is an open hypothesis rather than an established basis for attributing a property's cooling effect.

The biological contribution to cloud ice formation is also distinct from the claim that forest-derived particles control continental rainfall. The latter is not established by the evidence assembled for this paper. The reference set does not provide a dedicated review of biological precipitation or of Jehne's proposed changes in night-time radiation windows, so no quantitative conclusion is drawn about either mechanism.

The strongest extension of the framework is the proposal that water-cycle restoration could offset global warming. Ellison, Pokorný and Wild (2024) argue for a larger climatic role for forests in a perspective and synthesis. That argument is not a quantified demonstration of the cooling available from global restoration. The estimates from Zeng et al. (2017) and Li et al. (2023) concern observed greening and indicate relatively modest global land-surface effects, with larger regional effects. They neither establish Jehne's proposed global offset nor measure the full potential of future restoration.

2.6 Summary of the evidence

MECHANISM OR CLAIM	ASSESSMENT IN THIS REVIEW	IMPLICATION FOR EDDE
Evapotranspiration reduces local surface heating	Established across field and satellite studies	Provides the physical basis for assessing local cooling
Land evaporation supplies a substantial share of continental rainfall	Established; source and destination vary geographically	Supports a wider hydrological context, without attributing rainfall changes to a single property
Vegetation changes regional temperature and rainfall	Supported, with effects dependent on location, scale and conditions	Requires site-specific assessment
Lower albedo can offset evaporative cooling	Established	Must be included in net energy estimates
Increased soil carbon improves plant-available water storage	Supported, with a modest average effect and strong soil dependence	Does not justify a universal carbon-to-water conversion
Condensation drives continental moisture inflow through a biotic pump	Contested	Not used as an established mechanism in the metric
Forest biological particles control continental rainfall	Not established by the evidence reviewed	No quantitative attribution
Water-cycle restoration can offset global warming	Not demonstrated	No planetary cooling claim

The evidence supports measurement of local cooling and investigation of regional effects. It does not support using a property-level surface-temperature difference as a measure of net planetary cooling.

Part 3. The EDDE cooling assessment

3.1 Cooling, carbon and ecosystem condition

EDDE assesses four ecosystem processes (water cycle, energy flow, mineral cycle and community dynamics) and combines its diagnostics in a Land Health Score (Link, 2026). Its approach extends the field-based ecological-health framework described by Xu et al. (2019). Carbon uptake and local cooling are reported as outcomes associated with those processes.

The Water Cycle Index and Energy Flow Index assess functions that influence cooling, including vegetation cover and the maintenance of water exchange. The Land Health Score itself contains no land-surface-temperature band and does not calculate an energy-balance partition. The cooling assessment adds thermal observations and energy estimates to those condition diagnostics.

In the analysis of approximately 450 fields on properties in the UK, Italy and South Africa, the Evaporative cooling score correlated positively with the Land Health Score at about $r = 0.38$. Correlations within most individual properties were stronger, at approximately 0.5 to 0.8; the value at the case-study property was about 0.58. Estimated field-level carbon uptake correlated with the Land Health Score at approximately $r = 0.50$. One upland property did not show the positive relationship.

Across the assessed properties and geographies, two outcomes assessed by different methods therefore correlate with the Land Health Score in the direction predicted by their shared dependence on green cover, transpiration and photosynthesis. This is evidence that the diagnostic captures a functional property of the land.

The associations provide different kinds of support. The Evaporative cooling score shares much of its vegetation and moisture signal with the Land Health Score, so its correlation is best understood as internal coherence. Estimated carbon uptake uses a different combination of satellite inputs. The calculation combines productivity and soil respiration into a net carbon flux and shares fewer inputs with the Land Health Score. Its stronger correlation therefore provides further corroboration from the more independent of the two estimates.

In a simple comparison of each outcome with the Land Health Score, the pooled correlations correspond to approximately 14% and 25% of variance, respectively. Land condition is thus associated with variation in both outcomes, with a stronger association for carbon uptake. Climate, water supply, latitude and other factors also matter. These findings are open to further testing; they do not establish that changes in condition caused the differences in outcomes.

The same relationship was largely absent for the neighbour-relative Local cooling contribution band and whole-property carbon results. Those measures differ in scale and reference from the field-level indicators. Their weak associations are empirical findings, rather than necessary consequences of their definitions.

Cooling and carbon remain separate from the Land Health Score. Adding them to the score would risk counting the same underlying vegetation function more than once. Reporting them alongside it allows the reader to compare ecosystem condition with the associated outcomes.

3.2 Physical quantities and reported indicators

The assessment distinguishes observations from model estimates:

QUANTITY	MEANING	BASIS AND INTERPRETATION
Surface-temperature difference, °C	Property temperature relative to matched surrounding land during the same overpass	Derived from satellite thermal observations; depends on retrieval quality and control selection
Evaporative fraction and Bowen ratio	Division of available surface energy between latent and sensible heat	Estimated through a constrained surface-energy model
Transpiration fraction	Share of evapotranspiration assigned to living plants	Modelled from vegetation cover and crop-coefficient relationships, constrained by the landscape evapotranspiration total
Cooling power, W	Latent-heat flux multiplied by area, or an estimated additional flux relative to a reference	Gross and additional terms must be distinguished; the additional term is an order-of-magnitude estimate

The evaporative fraction is the share of net radiation, after the ground-heat term, used in evapotranspiration. The Bowen ratio is the ratio of sensible to latent heat. They describe the energy partition from different perspectives. Neither quantity alone distinguishes transpiration from evaporation at the soil surface.

EDDE converts selected quantities into two separate indicators, each on a one-to-nine scale:

INDICATOR	BASIS	QUESTION ANSWERED	CASE-STUDY PROPERTY
Evaporative cooling score	Growing-season evaporative fraction	How much of the land's available energy is used in evapotranspiration?	Approximately 6

INDICATOR	BASIS	QUESTION ANSWERED	CASE-STUDY PROPERTY
Local cooling contribution band	Matched-control temperature contrast during the hottest overpasses	How much cooler is the property than comparable surrounding land under hot conditions?	Band 8

The scales are not interchangeable. A property can sustain substantial evapotranspiration yet differ little from equally well-vegetated neighbours. Conversely, a strong contrast with hot surrounding land does not, by itself, establish a high absolute level of ecosystem function. The physical quantities provide the context needed to interpret each indicator.

3.3 Separating transpiration from soil evaporation

Both transpiration and soil evaporation cool the surface, but they describe different uses of water. Transpiration is coupled to living vegetation and production. A wet, bare field may also have a high evaporative fraction, even though it has little living cover. The transpiration fraction helps distinguish these conditions; total evapotranspiration alone cannot do so.

At the case-study property, the model assigns approximately 73% of growing-season evapotranspiration to transpiration and 27% to bare-soil evaporation. Across 44 fields, the estimated transpiration fraction ranges from about 0.37 to 0.89. Closed permanent pasture has the highest fractions; fields with more exposed inter-row or gap soil have the lowest.

The partition uses Sentinel-2 vegetation cover, the fractional-cover relationship of Carlson and Ripley (1997), and the FAO-56 dual crop-coefficient method (Allen et al., 1998). It is constrained so that the area-weighted sum matches the landscape evapotranspiration total used by the assessment. The procedure allocates that total among fields and between transpiration and soil evaporation. Agreement with the total is a model constraint, not validation of the allocation.

The practical value of this output is its connection to soil cover. It can identify where a greater share of water loss is associated with exposed soil and help guide field inspection.

EDDE's contribution is to combine established methods in a property-scale diagnostic that relates observed temperature contrasts and modelled energy and water partitioning to ecosystem condition. The transpiration split adds information that a temperature contrast or total evapotranspiration estimate alone cannot provide.

3.4 Matching the surrounding reference land

The observed temperature contrast depends on the choice of reference. A simple average within a fixed radius may compare a property with built surfaces, water, different elevations or a different coastal setting. Liu et al. (2024) show, in an urban context, that reference definitions can even reverse the sign of a surface-temperature contrast.

EDDE compares each property with matched surrounding land during the same satellite overpass. Controls are selected beyond an exclusion gap intended to reduce contamination by the property's own thermal influence. Evidence that thermal effects can extend beyond land-cover boundaries comes from studies such as Zhou et al. (2015), although that study does not establish the appropriate gap for an agricultural property.

The control selection uses comparable farmable cover, excludes built land and water, and restricts elevation to within 100 m of the property. Distance from the coast is also matched where relevant. The thermal source is ECOSTRESS (ECOsysteM Spaceborne Thermal Radiometer Experiment on Space

Station), NASA's thermal-radiometer instrument on the International Space Station. The assessment uses its land-surface-temperature data at 70 m resolution, filtered to overpasses from mid-morning to afternoon.

For each scene, the mean temperature of the controls is subtracted from the property mean. A negative difference indicates a cooler property. Using the same scene reduces variation associated with weather and overpass timing, but does not remove all effects of terrain, surface emissivity or viewing geometry. These remain sources of uncertainty.

3.5 Results for the case-study property

The detailed case study concerns a property in South West England. Its matched-control results are:

PERIOD	MEAN PROPERTY-MINUS-CONTROL SURFACE TEMPERATURE	95% CONFIDENCE INTERVAL, RANDOM ERROR	OVERPASSES
Growing season, April to September	-0.98 °C	-1.26 to -0.70 °C	211
Dormant season, October to March	+0.02 °C	-0.18 to +0.22 °C	182
Whole year	-0.52 °C	-0.70 to -0.34 °C	393

The property was approximately 1 °C cooler than its matched surroundings during the growing season and showed little difference during the dormant season. The growing-season interval excludes zero when random error alone is considered.

The assessment also assigns a systematic uncertainty band of approximately 0.75 °C, associated with emissivity differences between cover types and residual effects of aspect. This uncertainty is additional to the random-error intervals in the table. The platform classifies the seasonal result as resolved in direction but not robust in magnitude under its present uncertainty rules. The statistical basis for combining those two uncertainty components is not specified here; the random-error interval should not be read as a complete uncertainty interval.

For the hottest third of midday overpasses, ranked by the temperature of the surrounding control land, the mean contrast was -2.05 °C. This subset produces Local cooling contribution band 8. It summarises the hot-condition response within the same record; it is not an additional independent observation. The approximately 1 °C seasonal mean describes the growing-season contrast; the approximately 2 °C value describes the contrast under the hottest observed conditions.

The seasonal pattern is consistent with an evaporative mechanism: the contrast is present when vegetation is active and close to zero when activity is lower. It also argues against a constant temperature offset as the sole explanation. It does not isolate transpiration from every other seasonal influence or show that winter transpiration ceases.

These are land-surface temperatures at satellite overpass times. They are not measurements of near-surface air temperature or continuous daily temperature. The record also reflects the times and conditions for which usable thermal observations were available.

3.6 Accounting for albedo

EDDE estimates field-level broadband albedo from Sentinel-2 reflectance using the narrow-to-broadband conversion described by Bonafoni and Sekertekin (2020). For a net energy estimate, it subtracts

the additional shortwave energy absorbed by a darker surface from the estimated additional latent heat transfer. A net cooling estimate is not reported without this adjustment.

At the case-study property, some of the darkest fields are also among the strongest transpirers. The estimated evaporative gain and additional shortwave absorption nearly cancel. In two small wooded-pasture fields, uncertainty prevents the sign of the net term from being resolved.

This result illustrates the relevance of the albedo trade-off in a temperate setting. It does not reproduce the full radiative-forcing analysis of Rotenberg and Yakir (2010). The observed surface-temperature contrast and the modelled, albedo-adjusted energy contribution remain distinct outputs.

3.7 Property and field scales

The current comparative temperature claim is made at property scale. Field-level analysis at the case-study property found that valley position was a stronger predictor of thermal differences than vegetation or management variables. Cold-air drainage and pooling can therefore influence which fields appear coolest.

A field-level temperature contrast could consequently attribute a landform effect to management. Property-scale averaging and matched controls reduce some of this problem, although they do not remove it entirely. Field-level energy diagnostics remain useful, but do not yet establish comparative cooling contributions for individual fields.

Further development requires terrain normalisation and better treatment of albedo in small fields. These are separate sources of uncertainty: correcting landform effects in thermal observations does not resolve the spatial limits of an albedo estimate, or vice versa.

3.8 Heat extremes and seasonal resilience

Mean temperature differences between temperate properties and comparable neighbours can be small. Responses to hot and dry conditions may provide additional diagnostic information. EDDE is examining three measures:

- **Peak-scene anomaly:** the temperature contrast during the hottest overpasses, which may distinguish fields that limit surface heating from those that become much hotter.
- **Bare-ground contrast:** the difference from the observed hot end of bare-soil temperatures. At the case-study property, this is approximately 8 °C under the same scene conditions.
- **Stress response:** whether cooling is sustained during the hottest and driest observations.

The bare-ground contrast uses a different reference from the matched-control result. It is indicative and is not included in current client-facing cooling claims pending wider validation. None of these measures establishes a management effect without accounting for differences in water supply, landform and cover.

3.9 Reporting cooling power, carbon and disclosure

Cooling power is a rate of energy transfer, expressed in watts. It must be reported with the period and conditions over which it applies. It does not accumulate as a stored quantity. An energy total could be calculated by integrating a flux over time, but it would still not represent heat permanently removed from the Earth system.

The gross latent-heat flux describes all energy used in evapotranspiration. It includes flux that would also occur from a wet bare surface and cannot be assigned wholly to ecosystem condition or management. EDDE therefore does not publish the gross flux as an additional cooling contribution.

The additional contribution relative to a reference is estimated from the temperature contrast using a bulk surface conductance: a parameter representing heat exchange between the surface and the air. Its uncertainty is approximately a factor of two, so it is treated as an order-of-magnitude estimate. A more complete field-scale surface-energy-balance model is needed before reporting it as a precise power value.

Carbon uptake is reported separately. EDDE does not convert evaporative cooling into carbon-dioxide equivalents, because the assessment does not establish an equivalent net radiative effect, duration or permanence.

For nature-related disclosure, the metric is offered as supplementary evidence of ecosystem condition. It is not presented as satisfying a specific metric requirement under TNFD, SEEA, ESRS E4 or GRI 101. No standards-conformity claim is made by this paper.

3.10 Results across properties

The portfolio does not show a uniform cooling contribution. Approximately half the assessed properties were cooler than their matched surroundings during the growing season; the remainder were neutral to warmer. Most contrasts lay within the systematic uncertainty band. The case-study property was among the cooler properties rather than representative of the portfolio average.

The reference is important when interpreting these results. A property surrounded by similarly well-vegetated land may show little contrast despite substantial evapotranspiration. A warmer result may reflect poorer cooling performance, residual differences between the property and controls, or both. The Local cooling contribution band describes the relative contrast; the Evaporative cooling score and other energy-partition diagnostics describe the property's own function. Both require the accompanying uncertainty assessment.

Part 4. Limitations and further work

The current assessment combines satellite observations with modelled quantities. Its principal limits concern attribution, spatial resolution, reference selection and reproducibility.

Attribution and spatial resolution. The matched-control analysis is observational. Matching reduces selected differences between properties and controls but does not create an experimental comparison. The 70 m thermal resolution also limits field-scale interpretation, particularly where fields are small or contain mixed cover. Terrain normalisation is needed before comparative cooling claims can be extended to individual fields.

Energy estimates. The transpiration fraction is modelled rather than directly observed. Constraining it to the landscape evapotranspiration total preserves that total but does not establish the accuracy of the field allocation. The additional cooling-power estimate remains uncertain by about a factor of two. Albedo uncertainty can leave the net sign unresolved in small fields.

Choice of reference. Matched neighbouring land provides a relative comparison. It does not measure the gap between present condition and the best achievable condition for that cover and climate. A second comparison against ecological potential, informed by the coolest relevant conditions in the satellite archive, is proposed but has not been implemented.

Correlations among indicators. The reported associations with the Land Health Score require further analysis of shared inputs, differences among properties and environmental factors that may affect both the score and the outcomes. They do not show that an improvement in the score will necessarily cause a corresponding increase in cooling or carbon uptake.

Method documentation. Independent reproduction will require the observation dates and data-product versions, quality filters, exclusion-gap distance, control-selection details, score thresholds and procedures for estimating uncertainty. The method used to calculate confidence intervals should also specify how dependence among overpasses is handled. These details are not supplied in the present account. The internal portfolio analyses likewise require a defined sample and documented methods before they can support broader validation claims.

Implementation. The property-scale matched-control analysis, albedo estimates and energy partition are operational. Comparative field-level cooling claims and full integration into the client report suite remain incomplete pending resolution of terrain and albedo limitations.

Part 5. Conclusion

Water availability and vegetation influence local surface temperature through evapotranspiration and other energy exchanges. Jehne's framework brings these processes together with soil restoration, moisture recycling and proposed cloud and circulation effects. The literature supports local evaporative cooling and substantial land-to-land moisture recycling. It does not establish that restoring water cycles can offset global warming.

EDDE applies the local part of this science at property scale. At the case-study property, satellite observations show a mean growing-season surface-temperature contrast of $-0.98\text{ }^{\circ}\text{C}$ relative to matched surrounding land, increasing to $-2.05\text{ }^{\circ}\text{C}$ in the hottest third of midday overpasses. The dormant-season contrast is close to zero. The model assigns approximately 73% of growing-season evapotranspiration to living vegetation. Albedo partly offsets the estimated evaporative-energy benefit, and systematic uncertainty limits the precision of the net contribution.

These results support reporting cooling as a separate outcome alongside carbon uptake and ecosystem condition. Their value is local and diagnostic: they describe how land exchanges water and energy under observed conditions. Further work on terrain, model validation and uncertainty is needed to establish field-level contributions and strengthen comparisons across properties.

The assessment also provides a way to test whether improved water-cycle function sustains local surface cooling through hot and dry periods across different landscapes. Connecting those results to regional rainfall and net climate effects remains a separate research task. The methods and findings presented here invite scrutiny and further investigation of that connection.

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