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Key Points:

- We perform one of the first studies attempting to use luminescence directly as a quantitative sediment transport proxy
- We find that luminescence can reproduce known sediment transport values, but that careful attention must be paid to model applicability
- Luminescence of in-channel sediment appears sensitive to landscape dynamics such as changes in sediment flux and human alteration

Supporting Information:

- Supporting Information S1

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Application of a Luminescence-Based Sediment Transport Model

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Abstract Quantifying the transport history of sand is a challenging but important goal in geomorphology. In this paper, we take a simple idea that luminescence is bleached during transport and regenerates during storage, and use this as a basis to re-envision luminescence as a sediment tracer. We apply a mathematical model describing luminescence through an idealized channel and reservoir system and then compare this idealized model to real rivers to see if luminescence can reproduce known sediment transport data. We provide results from application of this luminescence method in three rivers from the mid-Atlantic region of the United States. This method appears promising. However, as a river system diverges from idealized conditions of the mathematical model, the luminescence data diverge from model predictions. We suggest that spatial variation in the delivery of sediment from hillslopes can be reflected in the channel sediment luminescence and that luminescence acts as a function of landscape dynamics.

Plain Language Summary How fast sediment gets from point A to point B in river systems is a surprisingly hard question to answer. Many of the scientific techniques we have are usable only over a span of years. This is a problem if one wants to compare current rates of sediment transport with long-term averages to understand the effects of climate change. In this paper, we present and apply a new method using luminescence, a property of sand that changes based on sunlight exposure. Luminescence is very interesting from a scientific perspective because it increases while sand is buried in river deposits and decreases while in sunlight. Because sand grains see different amounts of sunlight while traveling in river systems, we set out to connect measurements of luminescence with sediment transport rates. We found that luminescence appears to be able to tell us about sediment transport over very long time periods, which suggests that luminescence can be an exciting new tool. However, we found that the more complicated the river system, such as when there is a lot of human modification, the more difficult it is to use luminescence. Overall, luminescence shows promise toward answering scientific questions about sediment transport.

1. Introduction

It is surprisingly hard to answer the question of how sand travels through river systems. Nondescript grains of sand rarely give clues to their complex histories of repeated deposition and erosion. This is a problem as the long-term (10^1-10^6 years) transport of sand has significant impacts on landscape evolution, river infrastructure, and restoration efforts. In particular, it would be very useful to have information about the exchange rate with river deposits, the characteristic lengthscale of transport, and the virtual velocity of fine sand. The exchange rate (in units of percent sediment load per unit distance) describes the rate at which sediment in the channel is deposited and re-eroded from long-term (>1,000 years) storage reservoirs such as floodplains (Lauer & Parker, 2008; Pizzuto et al., 2014). The characteristic transport lengthscale describes the downstream distance over which $\frac{1}{e}$ or ≈37% of the suspended load enters long-term storage (Pizzuto et al., 2014). The virtual velocity describes the time-averaged velocity of a sand grain including time spent in long-term storage (Martin & Church, 2004). Unfortunately, these three quantities are essentially impossible to measure directly. However, they can be inferred from field and tracer studies

Previous efforts to tease out these three quantities used opportunistic tracer experiments, such as contaminant spills or radioactive material (Pizzuto, 2014; Sayre & Hubbell, 1965), or required long observational studies

(Bradley & Tucker, 2012). New methods with cosmogenic isotopes have potential (Lauer & Willenbring, 2010) but require expensive AMS measurements. Field studies and sediment budgeting have demonstrated success (Pizzuto et al., 2014) but can be costly if long field campaigns are involved. A method that avoids these complications would be of significant utility.

One potential solution may be to use the material property of luminescence as a proxy for suspended and partially suspended sediment transport (here the 90- to 250-μm size range). Luminescence in fine sand develops from background ionizing radiation and depletes following exposure to heat, pressure, or sunlight (Rhodes, 2011). Luminescence is typically used as a geochronometric tool on quartz or feldspar fine sand. Here we will use the term "luminescence" to describe the *sensitivity-corrected luminescence intensity*, a nondimensional quantity. However, the concepts here also apply to equivalent dose, a measure of absorbed radiation dose used in luminescence dating. One well-known source of uncertainty in luminescence dating is the incomplete removal of luminescence by sunlight. This challenge has motivated a number of studies that explore the processes of signal resetting (also known as bleaching), particularly in fluvial environments (Cunningham et al., 2015; Gray & Mahan, 2015; Jain et al., 2004; King et al., 2014; Rittenour, 2008; Stokes et al., 2001). The linkage between sediment transport and bleaching has also motivated interest in using luminescence to infer sediment transport (McGuire & Rhodes, 2015a, 2015b). Recently, Gray et al. (2017) developed a process-based model of luminescence in river sediment that in principle can be used to extract sediment transport information.

Ultimately, this study represents a simple idea: that luminescence is bleached during transport and regenerates during storage. We take this premise and ask, can luminescence in this framework reflect the transport histories of sand grains, and can we determine new information from it? We use the Gray et al. (2017) model and evaluate whether the patterns of luminescence in the channel are consistent with the model. We also evaluate whether sediment transport information derived from the luminescence reproduces known sediment transport information. We find that the model appears to work in locations that satisfy the model's assumptions. We also find evidence suggesting that the luminescence of in-channel sediment is sensitive to landscape dynamics.

2. Luminescence-Based Sediment Transport Model

We apply the model of Gray et al. (2017), which we briefly summarize here. Their model envisions an idealized channel-and-floodplain system in which grains of sand alternate between in-channel transport and reservoir storage (Pizzuto et al., 2014). Luminescence is treated as a property held by the sand grains, similar to radionuclide or contaminant concentration. Sunlight exposure during channel transport of sand decreases the average luminescence, whereas luminescence increases during long-term storage. This conceptualization can be expressed mathematically as

$$Q_s \frac{\partial \mathcal{L}}{\partial t} + \mathcal{L}\frac{\partial Q_s}{\partial t} = -u\left[Q_s \frac{\partial \mathcal{L}}{\partial x} + \mathcal{L}\frac{\partial Q_s}{\partial x}\right] + Q_s\left[f_E \mathcal{L}_b - f_D \mathcal{L} - \kappa \mathcal{L}^{\beta}\right] \tag{1}$$

where $\mathcal{L}$ is the sensitivity-corrected luminescence intensity (dimensionless) in channel sediment at streamwise position x (m), Q_s is sediment flux (m^3/s), t is time (s), u (m/s) is the velocity of channel sediment, f_E and f_D are the fraction of the sediment load Q_s that is either entrained from or deposited into storage per unit time (s^{-1}), $\mathcal{L}_b$ (dimensionless) is the average luminescence or equivalent dose of the reservoir, and, κ (s^{-1}) and β (nondimensional) are empirically obtained constants describing the removal rate of luminescence in subaqueous sunlight. Equation (1) describes the combined sediment transport and luminescence dynamics in this idealized system. The terms on the left-hand side describe the time evolution of the system. The first two terms on the right-hand side describe spatial variations in sediment flux and luminescence, and the final three terms on the right-hand side describe the effects of entrainment, deposition, and sunlight removal of luminescence respectively. See Gray et al. (2017) for in-depth analysis of equation (1) including derivation, scales, and parameter sensitivity.

For our application of the Gray et al. (2017) model to the field sites (described below), we use a simplified form

$$\underbrace{\frac{\mathrm{d}\mathcal{L}}{\mathrm{d}x}}_{\substack{\text{downstream rate of}\\ \text{change in luminescence}}} = \underbrace{\eta\left(\mathcal{L}_b - \mathcal{L}\right)}_{\substack{\text{exchange of sediment}\\ \text{with the floodplain}}} - \underbrace{\frac{\kappa}{u}\mathcal{L}^{\beta}}_{\substack{\text{bleaching}\\ \text{during transport}}}, \tag{2}$$

Table 1
Comparison of Known and Modeled Sediment Transport Parameters for the South River, VA

River	Reach length/catchment area	Method		$\bar{U}$	η	ℓ_s
South River, VA	60 km/550 km^2	Independently obtained values		1.2 (0.12–3.0) m/year	4.4 (1.7–43)%/km	10 (5–25) km
		Luminescence-obtained values	IR50	2.8 ± 0.1 m/year	4.3 ± 1.0%/km	23 ± 1 km
			pIR290	1.8 ± 0.1 m/year	6.5 ± 0.2%/km	15 ± 1 km

Note. Variable definitions: $\bar{U}$ (fine sand time-averaged velocity), η (rate of sediment exchange between channel and storage), and ℓ_s (characteristic lengthscale of fine sand transport). The independently obtained values represent the best fit value and the values in parentheses represent the 95% confidence interval. The source data and calculations for the independently obtained values are located in the supporting information.

which is a steady form of equation (1). Here κ, u, and β serve to control the rate of luminescence removal/bleaching with downstream distance. The η (s^{-1}) value, ($\eta = \frac{f_D}{u} = \frac{f_E}{u}$), describes the rate of channel sediment deposition and re-entrainment from the floodplain per unit downstream distance (Gray et al., 2017). Equation (2) stems from three simplifying assumptions:

1. Sediment is dominantly transported under *effective discharge* conditions (Wolman & Miller, 1960), here approximated as $\kappa, u \approx$ constant.
2. The luminescence response to forcing is damped such that luminescence in the channel reflects time-averaged conditions $\frac{\partial(\mathcal{L}, Q_s)}{\partial t} \approx 0$.
3. Downstream changes in sediment flux are small relative to changes in luminescence $|Q_s \frac{\partial \mathcal{L}}{\partial x}| \gg |\mathcal{L} \frac{\partial Q_s}{\partial x}|$, and concurrently, percent entrainment and deposition rates per unit distance are approximately in balance $f_E \approx f_D$.

These assumptions are needed to apply the model to field sites. We discuss the applicability of each assumption in the field site sections below.

We estimated the model parameters as follows. Full details are given in the supporting information. The variables κ and β were determined experimentally via sunlight exposure experiments. The $\mathcal{L}_b$ values were determined by combining estimates of characteristic storage timescale with luminescence regeneration rate on a site-by-site basis. Once these parameters are constrained, it becomes possible to use the luminescence data to estimate the others. The u and η parameters were determined using a curve-fitting procedure, wherein equation (2) was solved numerically using MATLAB 2016 and u and η were varied systematically. The best fitting values (Table 1) were found by minimization of the sum-of-squares differences between observed and modeled $\mathcal{L}(x)$. We present the values averaged from the top 10% of 6,644 model runs spanning the parameter space of $\eta = 10^{-9} \rightarrow 10^{-5}$ s^{-1} and $u = 10^{-3} \rightarrow 10^{-2}$ m/s and then calculating the average and uncertainty from these values. This parameter space brackets the zone of best fit to the field data (see the supporting information for details). To calculate the transport lengthscale and virtual velocity, we used

$$\ell_s = \frac{u}{\eta} \tag{3}$$

$$\bar{U} = \frac{\ell_s}{\tau_s} \tag{4}$$

where ℓ_s (m) is the characteristic transport lengthscale of fine sand, τ_s (years) is the characteristic storage timescale of fine sand estimated from sediment budgeting and geochronology, and $\bar{U}$ (m/year) is the time-averaged virtual velocity of fine sand (Pizzuto et al., 2014).

3. Application of the Model

We applied the model to three watersheds in the mid-Atlantic region of the United States: the South River, VA, Difficult Run, VA, and Linganore Creek (Figure 1a). This region is one of the few localities where we can compare our luminescence-estimate transport lengthscale, exchange rate, and virtual velocity against non-luminescence methods. These sites match our main assumptions to varying degrees as discussed below. We collected sediment in each river at locations ranging from the headwaters to the mouth. We sampled fine sand under the coarse armor in each channel and sealed the sample in light-tight containers for processing at the U.S. Geological Survey Luminescence Geochronology Laboratory (Gray et al., 2015; Mahan et al., 2014). We measured the sensitivity-corrected Infrared Stimulated Luminescence at 50° (IR50) and postinfrared Infrared

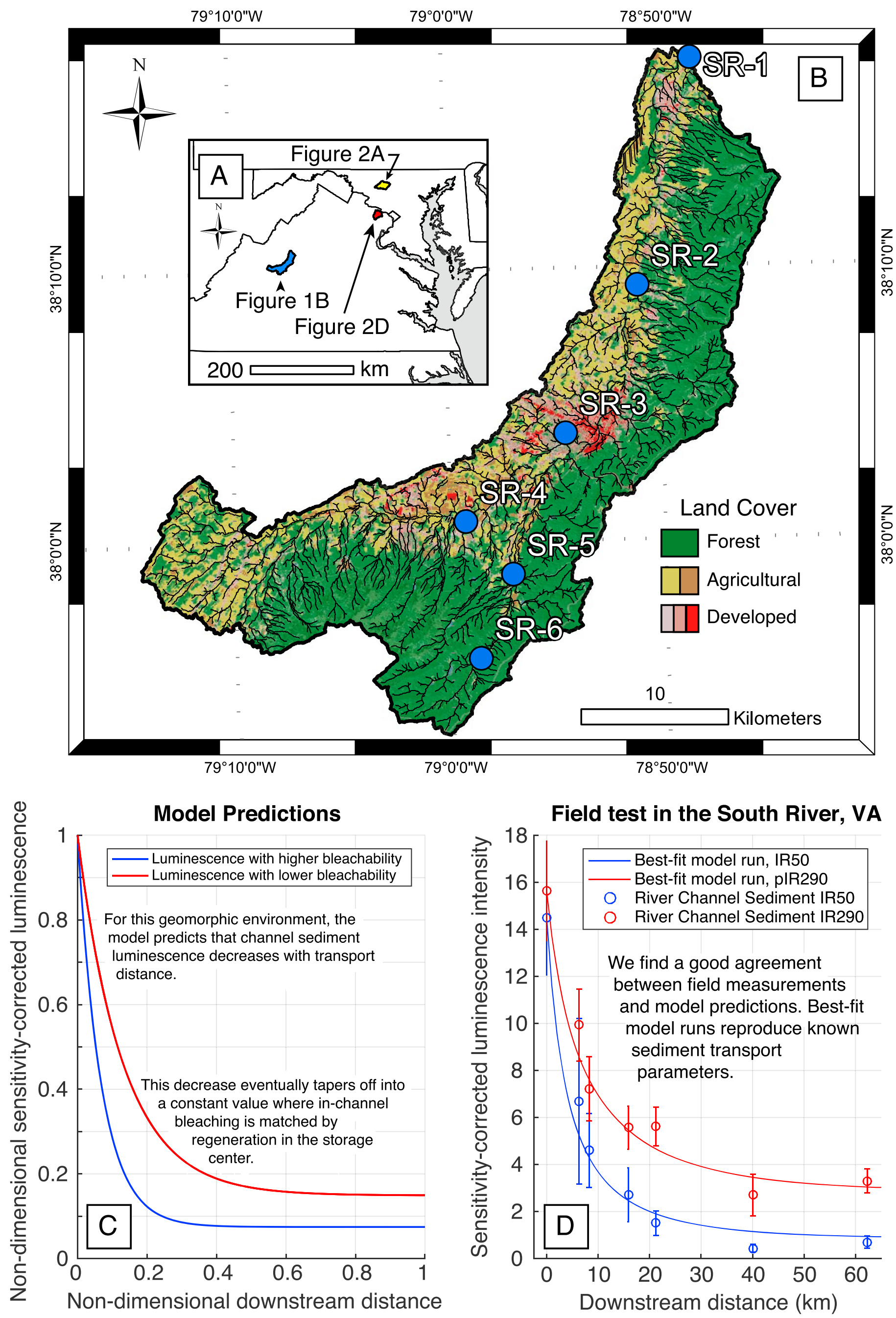

Figure 1. (a) Map of the South River catchment showing land cover and drainage network. Blue dots show sample locations. Land cover and elevation data in all figures are from Homer et al. (2015) and U.S. Geological Survey, The National Map (2016). (b) Predictions made by the Gray et al. (2017) model using equation (2). (c) Comparison of sensitivity-corrected luminescence measurements taken from channel sediment with best fit model results shown as lines. Circles show the average sensitivity-corrected luminescence intensity taken from large aliquots; bars indicate the standard error.

Stimulated Luminescence at 290° (pIR290) for each sample (Thomsen et al., 2008). We chose these luminescence variants as they have lower bleaching rates and can potentially better resolve sediment transport compared to quartz Optically Stimulated Luminescence (OSL) (Gray et al., 2017). We determined the $\mathcal{L}_b$ value empirically by collecting samples from the banks of the river following Gray et al. (2017). Detailed information on measurement protocol, machine specifications, and analytical results are provided in the supporting information.

3.1. The South River, VA

The site of the first model application is the South River in western VA (Figure 1b). Equation (2) predicts that the luminescence should decrease in a power law fashion and asymptotically approach a constant value (Figure 1c). Measurements of the channel sediment show a decrease in IR50 and pIR290 luminescence with downstream river distance that levels out with downstream distance (Figure 1d), consistent with the model predictions. We fit the model (equation (2)) to estimate u and η. Using the IR50 data, we obtain a transport velocity (u) of 4.9 ± 0.1 mm/s and exchange rate (η) of 4.3 ± 0.2%/km. Using the IR290 data, we obtain a transport velocity of 4.1 ± 0.1 mm/s and exchange rate of 6.5 ± 0.2%/km. We calculate a characteristic lengthscale (ℓ_s) of 23 ± 1 km for IR50 and 15 ± 1 km for pIR290. Dividing these lengthscales by a τ_s of ~8,400 years from K. Skalak et al. (personal communication, November 30, 2016), who used luminescence dating on floodplain deposits, using equation (3) leads to a virtual velocity ($\bar{U}$) of 2.8 ± 0.1 m/year from IR50 and 1.8 ± 0.1 m/year from IR290.

To evaluate these results, we must consider the assumptions of the model in the context of the geography and history of the South River. The river drains a 550 km^2 watershed and is a gravel bed bedrock river with fine grained deposits in the channel and in the floodplain (Pizzuto et al., 2016; Skalak & Pizzuto, 2010). The river is gently meandering with a sinuosity of 1.4, a consistent width of 40 m and bankfull depth of 1.5 m, and a slope of 0.0013 – 0.0024 for most of the study area (Skalak & Pizzuto, 2010). The South River appears to have a long history of fluvial deposition extending to tens of thousands of years (Skalak et al., 2016). The river's current conditions likely integrate a history of climate change and sediment transport since the Last Glacial Maximum (LGM). The South River contained approximately eight colonial era mill dams from the 1700s. These mill dams were almost entirely gone by approximately the 1950s (Pizzuto & O'Neal, 2009). The relevance of this history for the model assumptions is discussed below.

Assumption 1 stems from the effective discharge concept (Wolman & Miller, 1960). This concept posits that the majority of sediment transport occurs by floods at a characteristic frequency and magnitude, that is, the effective discharge. In terms of the luminescence, sediment will be dominantly transported under effective discharge conditions with a characteristic κ (bleaching rate) and u (transport velocity). To evaluate this assumption, we performed an effective discharge analysis for the South River using the United States Geological Survey's 100+ years of discharge data. We find that the frequency magnitude of discharge and sediment flux produces a clear peak, from which we conclude that the effective discharge concept can be adequately applied to the South River. We also find that the probability distribution of κ and u match the probability distribution of Q_s and can be described with time-averaged values (see supporting information for details). We conclude that assumption 1 is reasonable for the purposes of applying equation (2).

For assumption 2, the response timescale of channel sediment luminescence in the South River is on the order of tens of days of *cumulative effective discharge flow* (see supporting information for estimation). At least tens of days of cumulative flooding is needed to fully adjust channel luminescence to changes in sediment transport conditions. In contrast, flooding events in the South River occur on a generally much shorter timescale (hours to days). The difference between flooding and response timescale indicates that luminescence has a damped response to individual floods. The channel luminescence then reflects time-averaged sediment transport conditions integrated over the response timescale, which may be on the order of tens of years depending on the South River recurrence intervals. However, we must note that this response timescale is likely less important than the dampening effects of floodplain storage. As shown by Pizzuto et al. (2017), sediment exchange in a channel-floodplain system serves to average out upland signals of sediment load. Similarly, the luminescence of a channel-floodplain system would average out the short timescale (1 year) fluctuations of flooding into the long timescale (10^4) averaging of floodplain deposits ($\mathcal{L}_b$) via floodplain/channel exchange. Because such a system filters high frequency variation (Pizzuto et al., 2017), the exact value of the response timescale may be of less importance than the overall signal from long-term sediment storage.

For the field conditions of the South River, we note that climatic changes over the span of floodplain deposits (~10^4 years) are likely averaged into the channel sediment luminescence by floodplain-channel exchange and may not exert a strong control on the data we present here. Second, while we do not have data to conclude what the exact role mill dams would have on the luminescence, the averaging effect of channel exchange could have damped this effect as mill dam effected sediment is sequestered in storage. Additionally, we note that Pizzuto (2014) found that mill dams in the South River did not have a significant effect on estimating ℓ_s from mercury contamination. We interpret these findings to suggest that the sediment dynamics are not significantly altered by the mill dams. If the sediment dynamics are not significantly altered, then it may follow that the luminescence is similarly not significantly altered. For the purposes of this study, we do not find evidence to invalidate assumption 2.

Assumption 3 is concerned primary with changes in the downstream sediment load as a function of tributary input or the relative roles of deposition (f_D) and entrainment (f_E). To test the effect of tributaries, we performed a numerical experiment using the South River drainage network and an analytical solution of equation (1) from Gray et al. (2017). We find that tributaries are either small, and do not add much unbleached sediment relative to the volume of sediment in the main channel, or tributaries are large and deliver sediment with similar levels of luminescence due to long transport distances (see supporting information for details). We also examined the only available discharge and suspended sediment concentrations from United States Geological Survey gages at Waynesboro and Harriston from 2005 to 2007 (Eggleston, 2009) and compared these with changes in luminescence (see supporting information). We find that assumption 3 is generally upheld over this short timescale and that changes in sediment flux are not significant enough to affect our model results. It is important to note that as assumption 3 is applied over $\sim 10^4$-year timescales, it is difficult to fully validate its application using only modern observations. However, we note that the South River has a remarkably consistent width and bankfull depth for most of the study reach (Skalak & Pizzuto, 2010). For a dramatically increasing or decreasing sediment load, it can be reasonably expected that changes in the width/depth ratio would follow (Turowski et al., 2008). We conclude that assumption 3 is adequate for our analysis, but note that data beyond the scope of this study may be needed to fully verify its application.

3.2. Linganore Creek, MD

Our next application of the model is to Linganore Creek, MD (Figure 1a). The terrain alongside Linganore Creek, MD, transitions downstream from relatively gentle topography dominated by agriculture to a higher-relief domain dominated by forest cover (Figure 2a). The low-relief agricultural domain exhibits significant erosion (Clune et al., 2010) including soil mixing by tilling and livestock, and sediment delivery via sheetwash, rilling, and gullying (Gellis & Noe, 2013). During major storms, the agricultural reaches provide 44% of the suspended sediment load, with forests and stream banks providing the remaining 56% (Gellis & Noe, 2013). There is significant sediment storage along the river in floodplains (Schenk et al., 2013). A handful of now-breached mill dams exist (Schenk et al., 2013). Finally, Linganore Creek is host to Lake Linganore, a reservoir that has trapped sediment since 1972 (Sekellick & Banks, 2010).

Measurements of luminescence from channel sediment in Linganore Creek, MD, show a pattern of downstream decrease in luminescence in the upstream agricultural reaches, which changes to an increasing trend in the downstream forested reaches (Figure 2b). This trend again reverses downstream of Lake Linganore. The general downstream pattern predicted by equation (2) (Figure 1c) is not present. For this reason, we do not attempt to extract sediment transport information from this catchment.

The deviation of the measurements from Linganore Creek, MD, suggests that one or more of the assumptions in the model is not applicable. The most likely invalidated assumption is 3. The departure from model predictions correlates with a change in local valley relief and land cover. It is possible that this transition is associated with a change either in sediment flux or in the luminescence of sediment delivered from hillslopes and/or tributaries. The presence of significant agricultural erosion (e.g., Clune et al., 2010), and the contribution of this erosion to the river sediment load (Gellis & Noe, 2013), suggests that the flux of sediment from these regions has increased since the colonial era. The likelihood of substantial changes in sediment flux during the past few centuries renders equation (2) inapplicable.

Our data are consistent, however, with the hypothesis that luminescence in the channel may respond to changes in landscape dynamics. We hypothesize that the low-relief agricultural reaches are associated with a large flux of sediment bleached by light exposure during seasonal turnover of soil and during delivery to the channel via overland runoff. This is in contrast to the forested hillslopes, which lack agricultural activity. This could cause more unbleached grains to reach the channel compared to the agricultural reaches. This hypothesis is shown graphically in Figure 2c and as a black dashed line in Figure 2b. As a final point, samples from downstream of Lake Linganore (Figure 2d) show significantly lower luminescence than upstream. A possible explanation is that the channel sediment includes significant amounts of sediment that was transported over the reservoir spillway and thus may have greater light exposure and bleaching. Another possible explanation is that construction of the reservoir introduced bleached sediment to the channel and that some of this bleached sediment remains along the modern channel banks.

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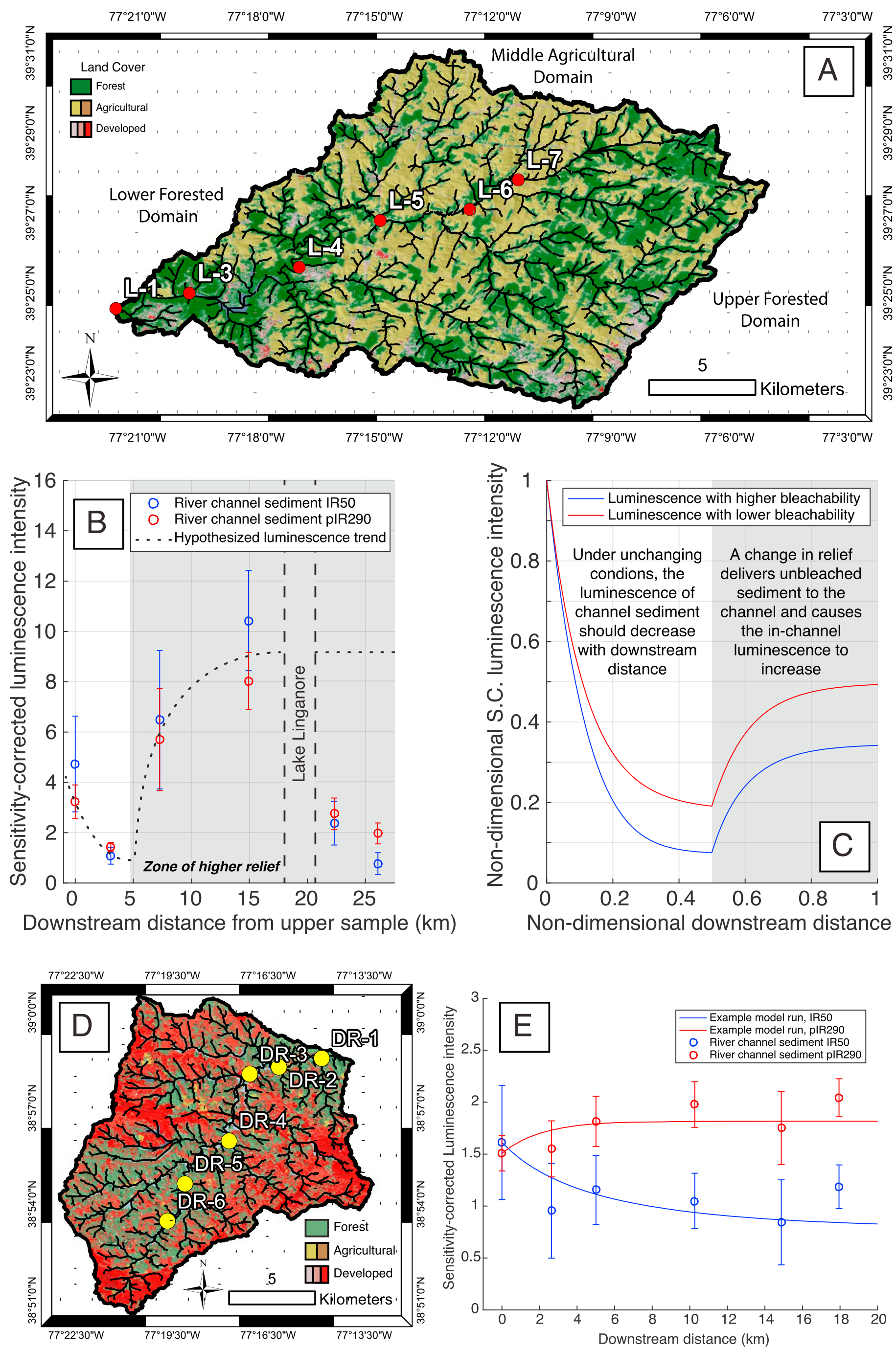

Figure 2. (a) Map of the Linganore Creek, MD, catchment showing land cover and drainage network. (b) Measurements of the in-channel sensitivity-corrected luminescence for Linganore Creek. Circles show the average sensitivity-corrected luminescence intensity taken from large aliquots; bars indicate the standard error. Gray zone shows area of higher-relief forested land cover. The black dashed line shows hypothesis of luminescence trend based on panel c. (c) Hypothesized behavior of luminescence at Linganore Creek. (d) Map of Difficult Run, VA, showing land cover, sample locations, and drainage network. Note high concentration of developed land use. (e) Field data results. The data show little to no change with downstream distance. We interpret this as an indication that human activity on sediment transport can obscure the natural signal by channel modification and construction/development runoff. Lines show example of possible model fits.

3.3. Difficult Run, VA

Our third application is in Difficult Run, VA (Figures 1a and 2d). Difficult Run is a 164 km^2 suburban watershed with a protected second-growth forested riparian zone in the piedmont physiographic province. The river is a gravel bedded pool-riffle stream (Hupp et al., 2013) with a bedrock gorge and knickpoint near the river mouth (Shobe et al., 2017). Our study is located upstream of this gorge. Deposits within the catchment consist of finer grained colonial era (hundreds of years old) deposits overlying coarser grained precolonial deposits (Hupp et al., 2013). The catchment experienced a long history of human influence including pastoral land clearing and a very high concentration of mill dams (Walter & Merritts, 2008) although none currently exist (Hupp et al., 2013; Schenk et al., 2013). Modification in the modern era consists of grade control, artificial channel armoring, superhighway construction, and increased storm runoff (Gellis et al., 2017). The river currently is net erosional in the upper reaches and net depositional further downstream (Hupp et al., 2013).

Measurements of the in-channel sediment luminescence for Difficult Run show a nearly constant value with downstream transport distance (Figure 2e). The IR50 values show a weak downward trend, whereas the IR290 values increase very slightly with downstream distance. We show example model runs in Figure 2e to suggest a possible trend. However, the data sets are barely distinguishable from a horizontal line, which contrasts with predictions made by equation (2) (Figure 1c). No sediment transport information was extracted as $\frac{\partial \mathcal{L}}{\partial x} \approx 0$, which precludes accurate determination of u, which in turn is needed to calculate the other sediment transport parameters.

The mismatch between equation (2) predictions (Figure 1c) and field data (Figure 2e) is likely due to invalidation of model assumption 3. It is possible that human influence via the generation of substantial colonial era sediment has caused a violation of assumptions 2 and 3. The large flux of sediment to channels that led to the aggradation of the floodplain (Hupp et al., 2013), facilitated by the high density of mill dams (Walter & Merritts, 2008), suggests a temporal violation of erosion/deposition balance in assumption 3 ($f_E \approx f_D$). Furthermore, Hupp et al. (2013) note a downstream shift from net erosional to net depositional sediment dynamics demonstrating a spatial invalidation of assumption 3 ($f_E \approx f_D$).

4. Conclusions

For the South River, the model assumptions are in reasonable agreement with the conditions at this location and the model is able to reproduce the independently known sediment transport information. At Linganore Creek and Difficult Run, the assumptions used in the model break down and the field data show a significant departure from model predictions. The particular landscape dynamics of Linganore Creek and Difficult Run appear to preclude the sediment transport application of the model in its simplified form. This is a scientifically positive result as the success or failure of the simplified model appears consistent with the applicability of model assumptions at each site. Accordingly, the luminescence data presented here helps generate hypotheses on the nature of sediment transport in these channels, which could serve as a useful tool. The performance of the model in these rivers provides support for using luminescence as a proxy for landscape-scale sediment dynamics.

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