NATURAL RESOURCES JOURNAL

Volume 62
Issue 2 *Summer*

Summer 2022

Who is in Charge of the Mud?

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WHO IS IN CHARGE OF THE MUD?

ABSTRACT

The Returning Rapids Project is a team of ordinary people who took an interest in the changes in Cataract Canyon. Our project is a bit of the beginning of a bad joke – a librarian, a pilot, a river guide, and a welder walk into a bar . . . but instead, they go on a trip and spend time talking about what a fast rate of change they are observing . . .

It is truly gone.

For centuries the structure stood high and imposing on the bluff that overlooked White Canyon−right as it ended its drainage into the Colorado River. In pre-European settler times, the area must have been widely used. It would have been a great place to live, roam, hunt, and grow crops.

When Anglos started traipsing through the area they saw and admired the high structure that jutted out above the river bottom as the Colorado swept through a long bend to the west. Starting with John Wesley Powell, on his second Colorado exploration 1871, parties visiting this area began leaving inscriptions on the slabs of rocks outside of the structure and on the inside walls of the many rocks that made up the structure.

Over the years, the inscriptions here made up one of the most comprehensive inscription locations of the entire stretch of the Colorado. When Gregory Crampton did his Glen Canyon Survey to assess all areas to be affected by the coming reservoir, he stated in his report, "One may hazard the statement that this site has been the primary tourist attraction in Glen Canyon until it was lost under the waters of Lake Powell."

And now, on a cool, sunny January day, with so many historic photos in our hands, we can confirm that it has been completely swept away. There is no more "Fort Moqui."

I am a part of a rag tag group of people that could be loosely termed as a "research team." We have been watching the changes transpiring along the Colorado

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† Editors' note: For the optimal viewing experience, the editors suggest viewing the pictures at https://digitalrepository.unm.edu/nrj/.

River that used to be covered by Lake Powell in Cataract Canyon. Questions arising from our research have led us further downstream, into areas of Glen Canyon.

When the Glen Canyon Dam began to fill and the consequences of the coming "Lake Powell" reservoir began to take effect, the slowed waters of the Colorado dumped its daily and annual flow of transported sediment into the lower half of Cataract Canyon. The Colorado River System is one of the more sediment laden river systems on the continent−if not the world. When you try to put a dam in the path of one of these rivers, sedimentation is an issue that must be confronted. Moving water can carry sediment, and when that flow is stilled all the sediment falls out.

Our research team, The Returning Rapids Project, has been cheering on the river carving out all the sediment that was deposited in the lower part of Cataract Canyon during the years of a filling and near full Lake Powell. It was very easy to be excited about the river showing an ability to restore itself, and, as the reservoir level fell, the return of rapids in Cataract Canyon!

We gathered pre-Glen Canyon Dam photos and over time matched them to observe the rates of change in Cataract Canyon, always asking: When is the next buried rapid going to return? Will it be anything like what it was prior to Lake Powell?

During the early days of our project we started to call the sediment that was deposited by the Colorado, as a result of being slowed by the reservoir, the "Dominy Formation." This was a nod to an oversight by the person who worked for the Bureau of Reclamation and championed Glen Canyon Dam and Lake Powell – Floyd Dominy.

In the truest sense of the saying, "be careful what you wish for," questions started to arise about where the mud that was being swept out of Cataract was being deposited . . .

In the winter, when it is less inviting to run through Cataract Canyon and when we have time to reflect on our research and further wrap our heads around what we have been observing, my wife Meg and I have done on-foot queries. On one of our trips, we wanted to go and look to see where the mud is going, and what effect it is having on the corridor of our beloved river.

And that lands us here, White Canyon, with historic pre-Glen Canyon Dam photos in hand and a harsh dose of current reality. We have now confirmed that 95% of all the history of the structure, that was called the most significant tourist attraction of Glen Canyon by the person in charge of surveying the area, has been wiped away. All but one flat sandstone like brick that comprised the Fort above White Canyon is now gone. There is one little slab of a piece we suspect made up the wall wedged in a crack downstream of where the proud structure once was. Ironically, "THELMA" is carved deeply in the zone that was clearly once the footprint of the structure.

In the background of the historical photos, the river is a hundred and some feet below the sandstone peninsula that juts out into the now delta of mud that inundated the river corridor, caused the river to be displaced, and whose currents swept away all but one ancient "brick" further downstream. The river sweeps by its confining corridor turn to the west now some 140 feet above where it once was. It would be easy to think that this was from backed up reservoir but that is no longer the case, it is backed up by 140 feet of mud.

We walked around, hopeful that it wasn't all gone. We tried to match some photos from Crampton and others. These efforts are rewarded with more confirmation that what hasn't been covered with the fine sediments of the delta has been swept away by the displaced river.

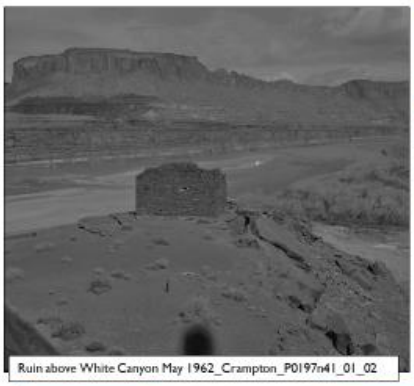
I want the river to be angry, but it isn't, it is just a geologic force. It was just in its annual cycle of high to low water, flowing in the path of least resistance – right over a cultural resource, right over the historic inscriptions − displaced by the effects of a modern culture that has been trying to harness a river.

In the areas of the advancing delta there are impacts being made that have largely gone unnoticed.

Above the mouth of White Canyon there was a historic structure that was referred to as "the primary tourist attraction in Glen Canyon prior to lake Powell".

This historic site not only had a commanding view from high above the river, it also lured many early river runners to carve their names there – JW Powell, Norm Nevills, Bert Loper.

When lake Powell was near full, this structure was under 100+ feet of water. In 2005, when the reservoir dropped to 3,555 ft, a pile of rocks came to the surface. Sometime between 2017 and 2019, the initial wave of the mud delta inundated this river corridor and covered the structure with mud. Sometime between 2019 and 2021, the displaced river flowing over the rock point swept almost the entire structure away.



Ruin above White Canyon May 1962_Crampton_P0197n41_01_02

A view of the point above White Canyon 1-17-2022

Fort "M " Spring 2005 Wade Graham

Blank area where the Fort used to stand
Meg Flynn 1-17-2022

A Matter of Infrastructure

For the sake of background, the first major dam and reservoir was established in the 1930s - Boulder Canyon Dam and "Lake Mead." This project was established for flood control and to attempt to contain the force of the Colorado River and its wildly fluctuating sediment dictated channel. The Boulder Canyon Dam greatly helped contain the irregular and uncontrollable rivers hydrologic behavior.

The Colorado River Basin is divided into two parts to address the different water demands of the states who have put their claim on the water of the Colorado River. The Upper Basin consists of Wyoming, Utah, Colorado, and New Mexico. The Lower Basin is made up of Nevada, Arizona, and the water hungry giant California. Lake Mead would serve as a major storage reservoir for the lower basin.

Not too long into the filling of the reservoir behind the Dam outside of Boulder City, it became apparent that there was a factor that could threaten the water storage of the reservoir. The river was depositing sediment at a rate that was

concerning and/or would greatly affect the life of the reservoir. This should have been no big surprise as it is one of the siltiest rivers in the world, but still, one big project perpetuated another to address shortcomings.

When viewed through the lens of where to put a dam to help stave off the sedimentation issue, the only better location would be smack dab in the middle of the Grand Canyon. Speaking strictly in terms of water quality for the end lower basin user, Lake Powell is the world's most beautiful location for a settling pond. When you dig around in the weeds of studies and scientific papers the sedimentation rates in Lake Mead are mentioned as a concern that is eclipsed by planning how to store and harness the water from the Colorado River system. And so, as a way to stop the sedimentation in Lake Mead, another dam could be built upstream to serve as a catchment of unwanted sediment.

Three Early Heroes

I never knew John Dohrenwend. I often struggle still to pronounce his name, but over time I have grown to know him through his pictures and research that he did before he died from a sudden heart attack in the late 2000s.

Together with John Weisheit, whose name I can never seem to spell right, this research team of two were the very early persons who were looking at sedimentation in the upper reaches of the Colorado.

Gene Stevenson, a geologist living in Bluff, Utah, was one of the first to raise concerns over the sedimentation issues on the San Juan. When the reservoir sediment displaced waterfalls started to appear on the San Juan, Gene tried to bring media attention to it. There is a story that in the mid-1990s Gene was able to get a Salt Lake City based TV crew to go down to Paiute Farms waterfall and do a piece on it. He was told that the piece would air on both the 5 pm and 10 pm news in Salt Lake City. It aired during the 5 pm news and never was shown on the 10 pm news. When Gene looked into it, he may have found that it was pulled for being too controversial a subject.

These three people deserve more credit than they will ever get. All of them had enough intimate understanding of river systems of the Colorado Plateau to know that trouble was brewing. Each of them tried in their own ways to point out to the general public that the idea of long-term inundation of the desert river corridors of the San Juan and Colorado rivers would shorter lived than the grand engineering schemes that the Bureau of Reclamation would claim. As recently as the mid-2010s, Gene Stevenson was pushing to get more detailed studies of the sedimentation issue in all of Powell.

Some people get paychecks, and some people have passions. If a love for a locale and an environment can overpower the subtle bi-monthly "just focus on what is working" bribery of a long-term career with a government agency, then some changes may have come to bear a long time ago. But yet here we are. Luckily John Dohrenwend, John Weisheit, and Gene Stevenson kept such great records that it helps provide so much context for what we are seeing unfold now.

Below Dark Canyon – USGS 1921

John Dohrenwend 2004

"A New Dam on the Colorado"

If this were a headline today it would be met with a myriad of commentary. Yet, just like so many other things happening because of the mud, there is about to be another dam on the Colorado. As reservoirs recede and are left to flow across the sediment that has built up in the upper reaches, it is very common for a river to find on its way out of its pre-inundation channel. This happened on the San Juan River in the mid-1990s, happened in the lower part of Grand Canyon, and is happening now as Cataract and Narrow Canyons end and Glen Canyon starts by the Hite Outpost.

In 2002, when Lake Powell dropped drastically due to a 30% of normal run off, the river settled onto its sediment delta in Cataract Canyon. From 2002-2004, it was a wild time to be a river runner through Cataract Canyon. Imagine navigating through a giant headward-ly eroding mud canal that was on the scale of a 4-lane highway. Every week it was altered by the geomorphic factors at play. The sides of the river would slough into like a calving glacier, these in turn would form fins of mud that would act like clay layer like rocks and obstacles in a rapid. In many places it wasn't safe to step out of the boat. Camps were hard to find and were often an exercise in trying to avoid getting the muddy silts all over your gear.

During this time, as the river settled into the delta it wandered out of its channel just below its confluence with the Dirty Devil River. This displacement of the channel isn't a significant variation from the channel in lateral movement, maybe less than 1/3 of a mile, but in terms of vertical displacement it is some 150 feet or roughly 20% of the elevation capacity of Lake Powell.

In the upper reaches of Lake Powell, a difference of 20 feet is making the difference of another rapid returning or not. The river incising itself into a slight ¾

mile wiggle out of its pre-glen Canyon Dam channel could mean a large difference in whether more sediment will be flushed out of lower Cataract Canyon, or if this area will start to serve as an unapproved sediment dam that may start to aggregate sediment to backfill all the areas we have seen the Colorado make progress in carving itself back to its historic channel.

It has been shown that when this type of sediment aggradation happens on sediment heavy rivers it will fill in and allow a rate of only one foot per mile of gradient. This is far more than the historic gradient of Cataract which is approximately eight to nine feet per mile.

There is an example of this concern on the San Juan River as it goes into the areas affected by Lake Powell. The San Juan River has always been river system that is so overloaded with sediment that during higher flows it has this great phenomenon known as sand waves. It cycles periods of carrying so much sediment that the river drops it out and creates a growing cycle of waves until the sediment is pushed away.

If you review pre-Glen Canyon Dam river running San Juan River running information, there is a fair amount of description of a difficult area called Paiute Farms. This is where the river spreads out and shallows across a vast series of ever-changing islands, caused by the river exiting a tight canyon and into a wider area of its corridor, making it easier for the silt laden waters to drop its sediment and not have to confront moving it out of its path.

There were warnings for people who were running the San Juan in pre-Glen Canyon times about this stretch of the river, that it is preferable to have at least a flow of 1,000cfs or more to be able to make it through without having to drag one's boats.

Glen Canyon Dam and the coming reservoir were slated to inundate the San Juan River to an elevation of 3707 feet above sea level. This would affect the San Juan all the way upstream to river mile 71 at approximately Grand Gulch. There were actually plans to make a marina at Paiute Farms as it would allow access and reservoir related economic opportunities for people on the Navajo Nation (the Dine'). Paiute Farms is at river mile 55 on the San Juan with a historic river elevation of approximately 3605, some 26 miles downstream of the high stand elevation of Powell and about 90 or so feet of reservoir depth.

In the filling and fluctuation of Powell's San Juan arm, the sediment issue was the first place that concerns about sedimentation really started to appear. It took until the mid-1980s for Lake Powell to be completely filled. During this time there were many good high-water flows on the San Juan and likely a large sediment delta formed, similar to the one on the Colorado mainstem.

It was during the late 1980s and into the 1990s that with a changing reservoir level, and a shrinking of annual flow of the San Juan from upstream diversions, changes started to appear. As the reservoir level settled to being managed at near full levels in the early 1980s, at around 3685 feet above sea level, to a lesser annual average reservoir elevation, the San Juan River, through the area between Clay Hills Crossing at river mile 57.5 and downstream, the sediment delta was exposed and where the river was displaced by its own sediment, new "rapids" started to appear. These rapids occurred just where the displaced river carved through its own sediment to harder strata.

In the late 1980s, the sediment load and fluctuating reservoir level displaced the river and the first of many rapids started to appear as the river was pushed out of its historic, pre-Glen Canyon Dam path. By the early 1990s, the San Juan River had been pushed out of its channel and the reservoir level had begun its decline down from a mid-1980s full pool level of 3700 feet above sea level. The river had deposited enough sediment into areas that the reservoir had inundated that it now flowed over a 30-foot-high cliff band creating what would become known as "Paiute Falls." It would be the first of the reservoir caused waterfalls on the modern Colorado River system.

During this time, the San Juan kept bringing its load of sediment to the places where it would be affected by both the reservoir and the new waterfall. And this new waterfall started having a sediment dam affect and upstream aggradation started to occur at a much faster rate.

It wasn't long before a change was noticed. In the lower few miles of the San Juan River run, from what was the High Stand of the reservoir at river miles 71 near grand gulch to the take out at Clay hills, crossing the sand bars worsened and built. This was also in the mid-1990s. Then this aggradation started to travel upstream and impact areas above the 3707 elevation of what the reservoir was slated to affect.

I don't know if many people noticed, but in the late 1990s the rapid at the mouth of Slickhorn Canyon was slowly inundated by the sediment and is now gone. Slickhorn Canyon is at river mile 75 and had a pre-Glen Canyon Dam elevation of approximately 3750 feet – or 40 feet above the reservoir level. It is subtle, but last the few times I have floated through this stretch it can be seen that the sediment is slowly building more and more upstream. If you knew it was there, it is not subtle that what was once a 300 yard long rapid is now gone.

This brings up many questions for me.

Was there ever a conscious decision made that the San Juan River should be put back in its channel to manage it for its best health or should the waterfall be allowed to persist? It seems that no steps were taken to look at this, which I read as the attitude with so many other issues, the reservoir level will return to its 3650-3700 level and the waterfall will go away.

Is anyone monitoring or aware of the sediment aggradation and the impacts of it upstream of the waterfall? How many people are aware that the sediment aggradation is now affecting natural and recreational resources well above the congressionally approved level of Lake Powell? Should a sediment management plan be made a put into place to address these concerns OR will it just be quietly allowed to keep happening?

Let's take this back to the Colorado and the possible heading of "A New Sediment Dam on the Colorado."

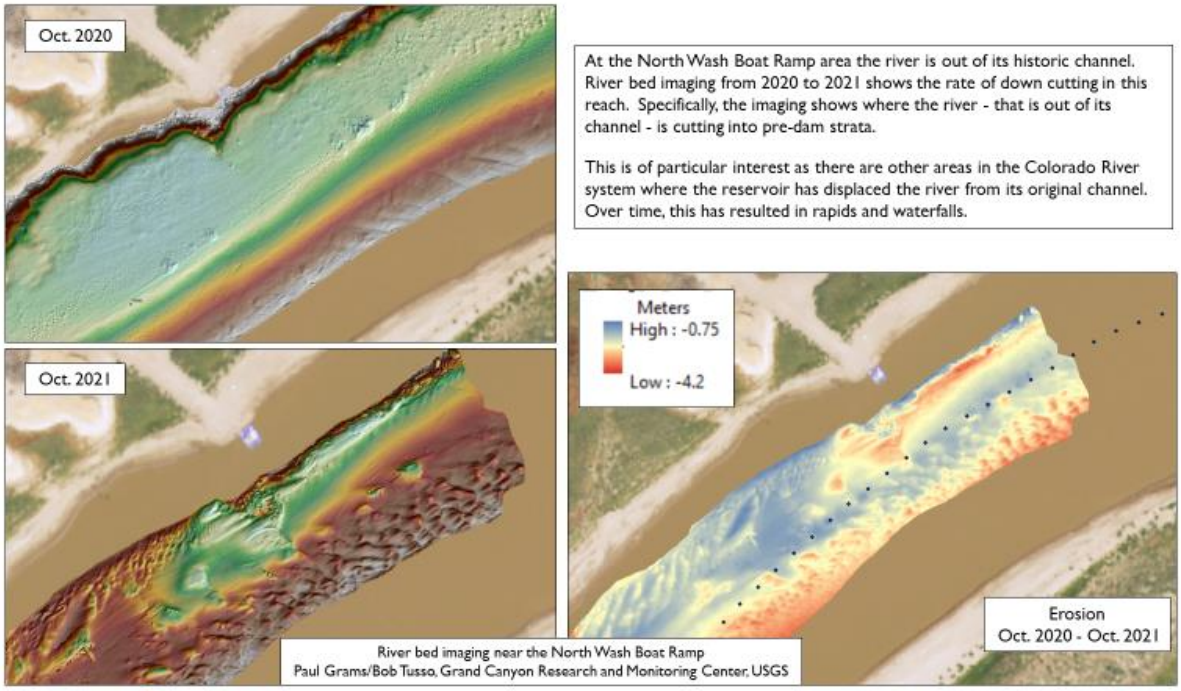
Just below the Dirty Devil River, the Colorado has been displaced by its sediment and is sitting perched approximately 150 feet above its original pre-Glen Canyon Dam channel. For the past few years we have been watching this area closely. In 2020 and 2021, we have been lucky enough to have Paul Grams and others from the Grand Canyon Research and Monitoring Center come on our fall Returning Rapids science trips through Cataract Canyon. On these trips we have been able to get riverbed imaging that gives us both riverbed make up but also riverbed location

based on elevations. This data helps us understand the rate of change we are seeing along this stretch of the Colorado.

In 2021, like a slow looming issue (que shark attack music) more and more bedrock is starting to show in the area where the river is out of its channel. As the spring run-off of 2022 begins to flow over this area, more rock is showing every week. Also, our field observations of more sand bars show above the Dirty Devil River are starting to have us wondering if we aren't starting to see the beginnings of sediment aggradation caused by a new dam.

Clearly there is a decision to be made here. Do we want to let the river cut down to the bedrock and allow a rapid/waterfall to form, or should we look at putting the river back in its channel so that sediment can be pushed out of Cataract Canyon and allow that area to restore itself? In the face of a lower reservoir level future, how should this area be managed?

But the biggest issue still comes back to who manages the mud? Who is in charge of this stuff and all its impacts and liabilities?



OK With Being a Fool

When we first started doing Returning Rapids science trips, I had a conversation with one of the great scientists who joined us.

The conversation was about dams and reservoirs and how they are intended to be a savings account of a water resource. This scientist told me that it was foolish to think that a reservoir would persist at a certain capacity or level of being full. I didn't really understand the in-depth operation of the Colorado River Storage project.

I am always happy to be a fool who tries to maintain good self-awareness, rather than an overly self-assured expert – you learn more that way. But from my foolish perspective I have more questions.

If the larger purpose of the Colorado Water River Storage Project is to ensure water for the population of the Southwest for the foreseeable future, isn't thinking through all the issues important? If everyone knew that sedimentation was an issue – shouldn't it be closely paid attention to?

Over the past year, I have been lucky enough to meet many people from the Bureau of Reclamation, a few state water commissioners, and other people heavily involved with Colorado River issues. I feel that our project is a research and monitoring project watching the changes we are seeing in Cataract Canyon. I also feel that we are discovering key questions that should get asked to those who may have the ability to influence outcomes one way or the other. It is from that perspective, that I have been asking people – "Who manages the mud?"

So far, the answers have been non-committal and usually along the lines of, "That is something we will have to look into," "Are there liabilities that should be considered?" and my favorite, "Do you camp near that stuff? Is it dangerous?"

Deltaic Progradation

When the weather and hydrologic cycle of the Colorado going into Lake Powell really started to change, the sediment delta that was deposited in Cataract Canyon was still mostly in Cataract Canyon. And during the years of the filling and near full reservoir, it was mostly easy to ignore because it was under the waters of Lake Powell.

From 2002-2005, John Dohrenwend and John Weisheit undertook a huge monitoring effort, watching the changes of the delta. Those two made a photo record of the first major water level drop of the reservoir. They also paid attention to the delta that was being mobilized by the river flowing across its own delta.

In simple terms, the water of the Colorado carries lots of fine sediment – some simplify it by saying seven Mississippi barge loads go by any place on any given day. All this sediment dropped out into Cataract Canyon over the course of the years of the reservoir filling. As the reservoir level dropped, there were now two factors in play: 1) the continuous sediment load of the river, and 2) the possibility of mobilizing the sediment that the river was carving through as it worked its way through lower Cataract Canyon. So the sediment deltas in Powell continues to grow.

Now, with the lower reservoir levels, the delta has started to become super-charged and has been moving downstream from the Hite area and further into the upstream most parts of Glen Canyon. This process is known as Deltaic Progradation.

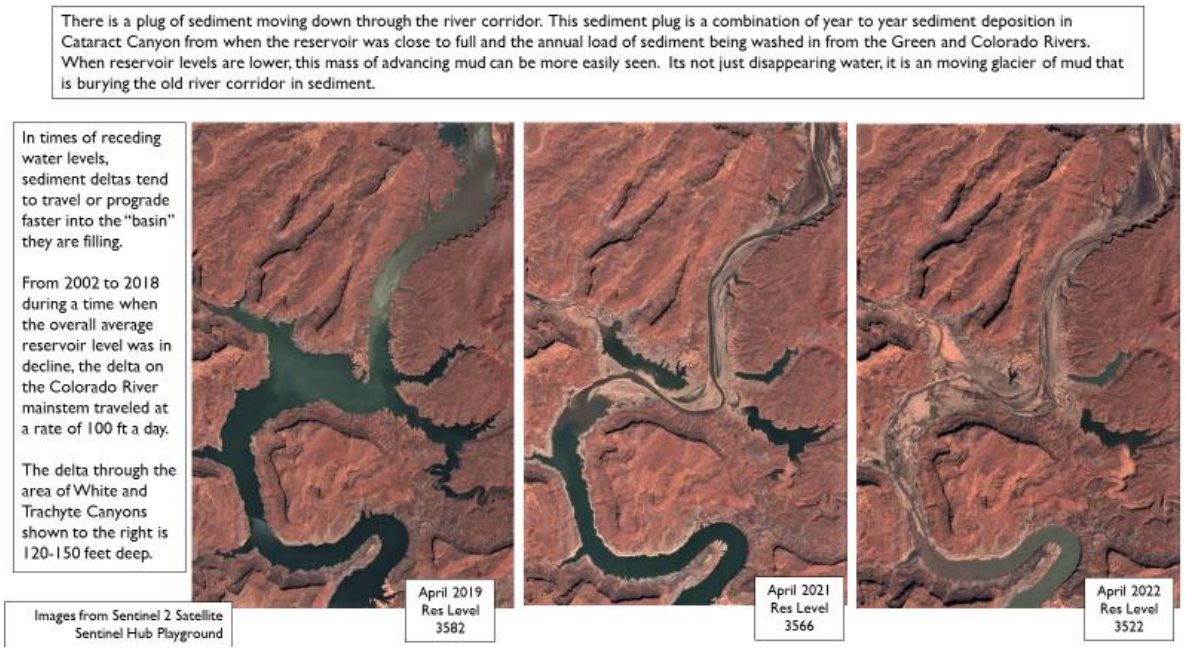
As I see it, it was one thing to flood Glen Canyon, but it is another thing entirely to watch the river corridor get inundated with a giant moving mass of mud.

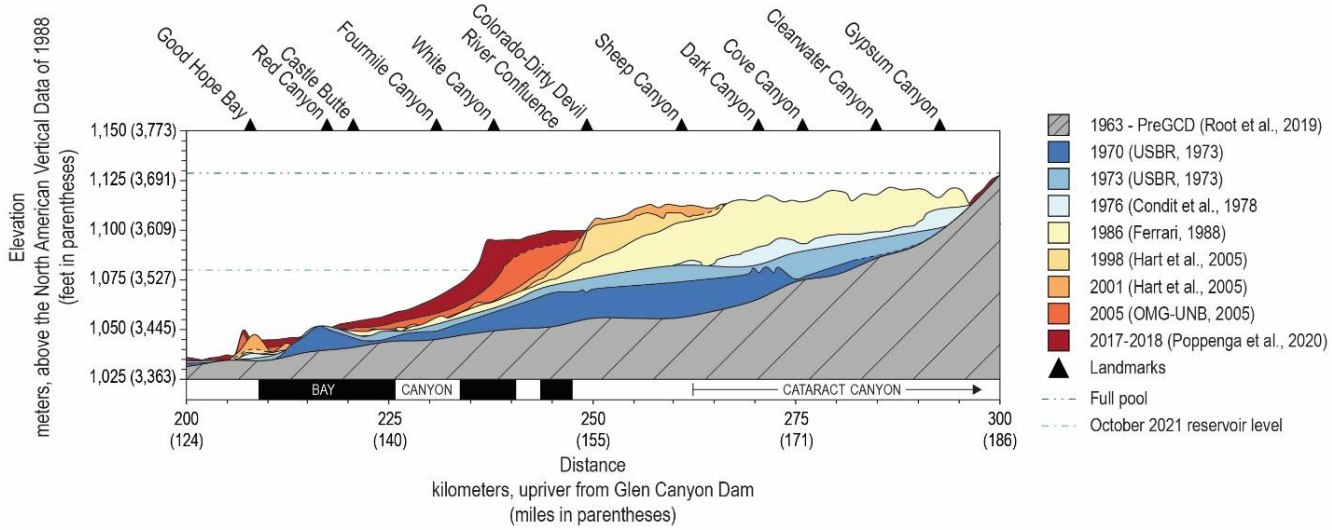
Over the past year, we have been watching the delta move down the river corridor via satellite imagining and visits to certain areas like the fort above White Canyon. The delta is a river corridor canyon wall to canyon wall mass of sediment. It is roughly 120-140 feet deep – and it is moving like a giant mud glacier.

The movement rate is mind blowing. I started guessing that the deltas are advancing a mile per year – or 14 feet a day. But that was way off. I checked with satellite photos and found a student group project at the University of Utah that

observed through satellite photos from 2002-2018 that the Colorado mainstem was moving at a rate of 100 feet a day and the San Juan an even faster 130 feet a day.

That is like watching a city block get covered by a 120-foot-tall mud glacier every week! Week after week into years and years.





The Tailings of Mining the Colorado for its Water

I live in Moab, Utah. Prior to tourism being our main industry, uranium mining was the chief driving economic factor. Ore from mines around the region was trucked to the Atlas Uranium mill just north of both the town and right on the northern shore of the Colorado River.

In the mid-1970s the uranium industry went bust, the company went bankrupt, the mill shut down, and left on the shore of the Colorado River was a huge semi radioactive pile of dirt. It took close to 20 years for a clean-up project to get started. For the past 25 years this pile has been getting relocated away from the Colorado to a desolate spot up 30 some miles to the north of Moab.

When I am out walking around on the giant flats of sediment, I can't help but think that all the sediment is a by-product of mining the Colorado for its water. The latest figure I heard from some of the USGS scientists we partner with, is that there is 2.25 square kilometers of sediment now in Lake Powell. And it is between 6-10% of total storage capacity. Think about it this way: right now if Powell is only 25% full, at least 1/4 of that "storage" capacity is mud. And it is going to keep growing.

The parallels between the uranium tailings pile in Moab and the mass of growing mud in Lake Powell are multi-faceted. While the industry was working to extract its final product, some of the byproducts are being ignored. The planning ahead and management of the potential harm is not specifically being thought through. And currently between Powell and Mead, it looks like one of the two reservoirs is heading for bankruptcy.

I think about all the fighting that happens over the water of the Colorado. How this state gets an allotment of "x" but this other state gets a lesser percentage of water because they weren't using it first. I would like to see each state take an equal part in the management and remediation of the sediment.

The Mud is the Colorado's Salmon

I would give credit to a friend who tries to be aware of issues going on in many of the large river systems of the world who simply said, "the mud is the Colorado's salmon issue." It always makes me laugh because I have never heard anyone outright say that the mud is significant, yet the mud is going to be ***the*** factor that the Colorado River storage project will have to reckon with in the coming decades – especially in the face of the current period of drought and aridification.

I was recently talking with a scientist who was getting ready to do a river trip down the Grand Canyon. This person has been running rivers for 25-30 years with many runs through the Grand Canyon. We were talking about the mud in Powell and all its affects. He said, "On this trip I am about to go on, they are issuing everyone cots. This is a new thing in the past few years because the beaches aren't getting replenished by the flow of sediment that there used to be prior to Glen Canyon Dam. So now we get to sleep on cots because there isn't enough sand to sleep an entire trip at many of the camps."

I would have never thought the value of a good beach would hang in the balance, but if the mud is the salmon of the Colorado – then the river carrying the sediment from one nice beach to another eddy is truly a sign of a healthy Colorado River system.

There are dams in the northwest that have fish ladders and other means to let fish travel past the obstacle created by the dam. But in Glen Canyon, engineers claim they have bought themselves 700 years of sediment fill time before the Dam becomes obsolete with mud. Maybe we shouldn't have settled for that and just realized we should take on the problem with a current sediment management plan instead of a "let the future generation try to solve that one" approach.

The Math Problem

How long does it take something that is traveling 50 feet a day to travel 27 miles?

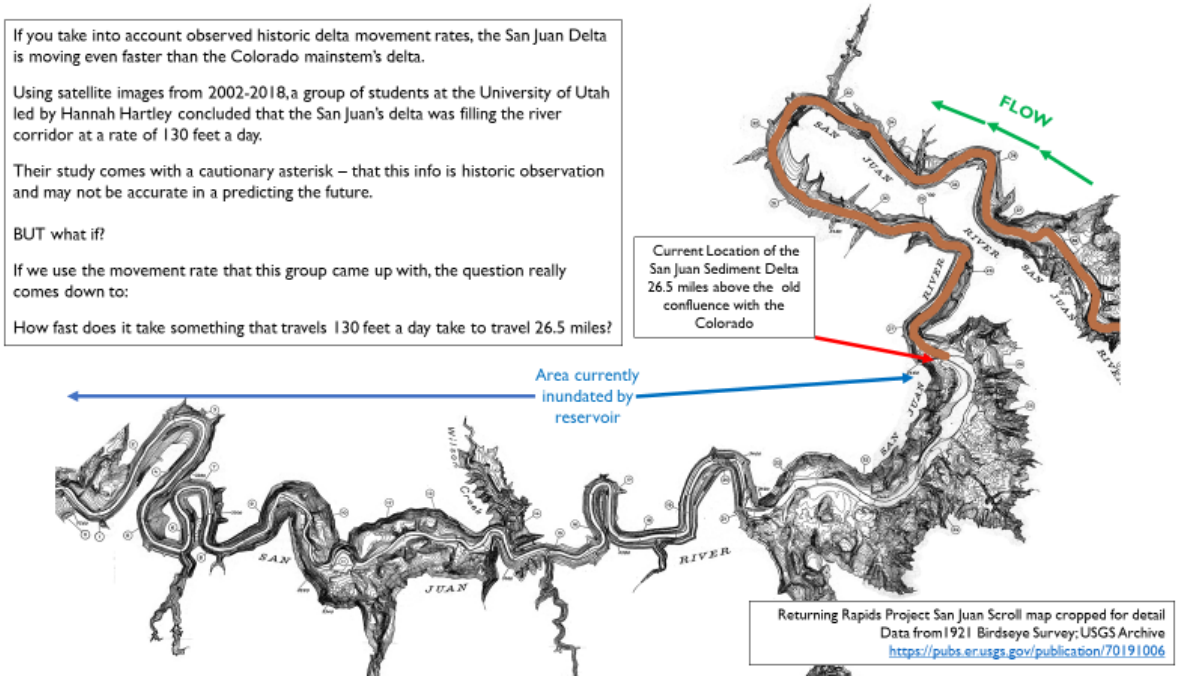
50 times 365 gets you 18,250 feet in a year.

8,250 feet divided by 5,280 in a mile equals 3.45 miles in a year. (Let's just round it down to 3.25 feet a year).

27 miles dived by 3.25 miles a year is 8.3 years

The sediment delta on the San Juan River is currently 27 miles above the San Juan's old delta with the Colorado.

This is half the rate of what the University of Utah group provided in their data.



So conservatively, there could be a mud blockage on Lake Powell at the mouth of the San Juan River. It may take 700 calculated years for the geographic basin to fill up and become obsolete. However, the sedimentation rate is already affecting natural, recreational, and cultural resources in a way that is not being properly managed.

For some math problems you just wish there were easier answers.

Conclusion

I often think about how the Colorado River is so much more than the clear water that comes out of all of our taps. There is the comforting sliding purr of an eddy and its glassy reflection during a calm dusk. There is the mud, where if put strategically is beneficial and could feed millions; when the Colorado was in flood, it flowed outside its banks and brought its well-traveled silty nutrient soils into the floodplain where the vast majority of the farmlands in the Imperial Valley of Southern California are located. There is the light off of the water. In monsoonal times, there is carving and voraciously changing events. In times of scarcity there is an overwhelming quiet. As it cycles through an annual hydraulic cycle each year, the Colorado is shirking to hide amid its arid surroundings.

Last year, I spent time with a journalist who was worried that we were watching the demise of the Colorado. That this river would simply cease to exist, consumed by the appetite of our current civilization. I expressed how I strongly feel the Colorado would outlive me and everyone I could currently name. Like so many things, the river will do what it geologically does. If we are serious about trying to manage it as a whole for the greatest overall benefit, we should pay more attention and answer the question, "Who is in charge of the mud?"

Dirty Devil Headwall Surface Elevation Survey, 2022

Gypsum Canyon Rapid, 2021

Nick Point (John Dohrenwend, 2003)