Integrating Water Stress into Corporate Bond Credit Analysis – Developing a Model

19 December 2014

This Working Paper

This report represents our latest thinking about how to integrate water stress into bond credit analysis. This report sets out comments and suggestions made by participants at our 8 December workshop and 9 December webinar, in response to our “Methodology” and “Recent Reports” presentations; as well as replies to three questions we posed. This working paper also takes account of feedback during calls and meetings held with some expert council members and financial institution partners (FIs) who were not able to attend the events. It then sets out recommendations on how to develop the project.

1 Introduction

At the workshop on 8 December we gave two presentations

- “Integrating Water Stress into Corporate Bond Credit Analysis; Recent Reports and Tools”
- “Integrating Water Stress into Corporate Bond Credit Analysis; Developing a Method”

The workshop was attended by representatives of the FIs who are partners in this project as well as members of this pilot project’s expert council and took place at PRI’s offices in London. On 9 December we gave the “Developing a Method” presentation to a phone audience of eleven people.

Participants at both events had received two concept notes, namely “Integrating Water Stress into Corporate Bond Credit Analysis: Recent Reports” and “Integrating Water Stress into Corporate Bond Credit Analysis: Developing a Model”. On both occasions we also asked participants three questions.

2 Recommendations

Following discussions with FIs and expert council members on 8 and 9 December and more recently, and in the light of recommendations we received, we can give more clarity on the form of the project through to March. We will undertake modelling of specific companies in three selected sectors, integrating water consumption data and TEV (total economic value) water costs. We propose to analyse key bond issuers in these sectors, populating the model with company data that allows us to undertake this work. After receiving the prototype model in March 2015, FIs will be able to scrutinise the model and our analysis of companies, as well as using the model to analyse other companies in these three sectors, and companies in other sectors.

This is a development in our thinking following the December consultation phase. Prior to the consultation, the goal was to create a stand-alone model or tool, which FIs would receive in March, and use to analyse companies. Having spoken to FIs, we shall analyze a number of companies in three sectors, as well as developing the model. We do this additional analysis, in the understanding that the FIs, after receiving the model in March, will use it to analyse other companies and perhaps other sectors, providing feedback to us on the model, and how it might be further developed (see page 4).

On 8 and 9 December we asked participants three questions. Following consultation on these questions, we now recommend that:

- in addition to modelling the mining and power sectors, we should model the beverages sector (pages 5, 7-10)
- we should model company financials rather than company archetypes (page 5)
- we should model the response of companies to higher water charges, or regulatory and physical constraints in water availability, considering the water capex and opex opportunities open to firms in the three sectors (page 6)

An updated timetable reflecting these recommendations is included on page 11.

3 Suggestions Received in Response to Our 8 and 9 December Presentations

We propose integrating water stress costs into an analysis of companies' credit strengths in three sectors of the economy. We aim to calculate a shadow price or total economic value formula for water, able to estimate values for different locations. We then intend to integrate this information into a valuation of firms in key sectors, overlaying location-specific water and production data with the location-specific shadow price of water. Where location-specific data is not disclosed publicly by companies, a hierarchy of proxies will be used to estimate water use. The total economic value of water should represent a scientific base to determine an upper bound for stress-testing companies' financials for water costs.

3.1 How might firms respond to higher water costs?

Participants on 8 and 9 December supported the approach of using the total economic value as an upper bound for the water costs that companies could face. Beyond that, participants were also interested in how companies might respond to higher water costs. Firms might respond to higher water costs in four ways. A firm could:

-simply absorb higher costs

-cut production in response to higher water costs

-undertake capex (e.g. invest in technology or infrastructure) to try to increase supplies or reduce their water requirements

-try to pass on costs

Recommendation: we will try to model a range of company responses to higher water prices

3.2 How should we distinguish between water use and water consumption?

A second point of discussion related to the distinction between water use and water consumption. Thermal power generators, for example, use a great deal of water for cooling, but return most of this water to the environment, in a condition similar to its original state, so their 'consumption' is low. Other industries, however, like agriculture, consume large amounts of water, for example in the growing of vegetables and fruits.

Most participants thought we should distinguish between water consumed and water use. However, several thought that although water use may have less of an impact on the environment than consumption, water use still does impose costs. For example:

- while a power firm use water for cooling, the water cannot be used by others
- the nature of the water may be different when it is returned, for example warmer
- pricing water use (not just consumption) is a good way to reflect the risk that access to water use may be denied in the future

These participants thought thermal plants should be charged for water use, not just consumption, though they accepted that the water use price considered should be lower than the consumption price.

Recommendation: we will try to model and explore this important distinction, while considering a lower price for water use than water consumption

3.3 Might we consider economic water scarcity as well as physical water scarcity?

One participant asked if our model would allow us to look at "economic water scarcity" as well as "physical water scarcity". By physical scarcity, the participant means the level of water supply and demand available at any region, by virtue of the surface water, ground water, rainfall and water demand at any region. The concept of economic scarcity revolves around the amount of water actually made available through local infrastructure. Water may be economically scarce in a region where there is no physical water scarcity, if there has been insufficient investment in infrastructure and planning in a region. Our model currently looks at physical water scarcity. However, there might be a way to overlay local authority competence in the model as a way to consider economic scarcity.

Recommendation: Further research will be undertaken to explore options to incorporate water risks linked to economic scarcity

3.4 Are water abatement cost curves of assistance?

One participant suggested we think about water abatement cost curves, in a similar way to the carbon abatement cost curves used in the climate change policy arena. However, it was pointed out that water abatement costs are location specific, whereas carbon dioxide abatement costs curves are not site specific (as carbon dioxide is uniformly dispersed it does not matter where CO_2 reduction takes place, whereas the value of water is highly location specific). So while carbon abatement cost curves may be useful internationally, water abatement cost curves are useful only for a specific location.

Recommendation: we will focus on a few technologies to create water or reduce water usage (not cost curves), while trying to make the technology costs location specific

3.5 Can we model price dis-continuities?

Some participants thought that rather than water prices rising linearly, firms would instead have sudden disruptive impacts, such as supply shortages due to lack of water or government or local authority intervention. Some participants thought that since water prices are highly regulated, a crisis situation would need to occur before prices rose significantly.

Recommendation: we will consider how to integrate possible price dis-continuities in our work

3.6 Focus on modelling companies instead of tool development

One Financial Institution suggested that we should model water stress costs by analysing a representative universe of companies in the selected sectors, rather than designing the tool with the expectation that users would research company water usage themselves.

The FI felt that if we developed a tool for FIs to conduct the company-specific analysis themselves, the uptake amongst FIs likely would be poor, particularly if the FIs themselves have to enter a lot of location-specific information on each company to derive a result. It may be better if we instead undertook the analysis, and then made our results available to the FIs, enabling them to use the model to test and adjust assumptions, with an option also to analyse additional companies.

If we do undertake this initial research ourselves, then when the FIs receive our excel model in March 2015, this will have been prepopulated by us with data, with financial and water data entered for each company, including credit ratio analysis both 'before' and 'after' water shadow prices are taken into account. So FIs would be able to see how we had undertaken our analysis. We would be providing a 'point in time' sector assessment, which analyses five to ten companies per sector.

This route would allow us to progress with analysing companies in the sectors we cover, rather than focusing on the task of developing a stand-alone tool that would be constrained by the availability of location-specific water data available to users.

Recommendation: we will develop the model and analyze companies using the model though to March, when we will present our initial results and model to the FIs. At that stage the FIs will test the model themselves, providing us with feedback on how useful is the model and how it might further be developed.

4 Responses Received to Our Three Questions of 8 and 9 December

At the 8 and 9 December presentations we put three questions to the participants on how we might proceed with the economic modelling. We set out the three questions below and some of the key answers we received.

Methodology question 1

We propose analysing the following two sectors: mining and power generation
Are these the best sectors to focus upon? Which should be our third sector?

Pulp and Paper
Oil/Gas (Shale)
Food and Beverages
Other?

We had a number of replies to this question, ranging from one participant who thought we should only cover two sectors, to others who respectively championed pulp and paper, food and beverages, technology, building materials/construction and shale gas. However, the two most popular suggestions for a third sector seemed to be pulp and paper or food and beverages. Below we summarise some of the discussion on this topic.

One FI suggested that we should not choose regulated utilities, because these firms are able to pass on water costs relatively easily. Another suggested that we should look at the telecommunications, because of the amount of water telecommunication firms use in data centres. However, questions were raised about the telecommunications sector because it does not issue many bonds and is underleveraged with lots of cash; so adjusting telecommunication financials to factor in water pricing may have little impact. Questions were also raised as to whether we could access good information about data centre locations and their water use.

One participant suggested that we analyse the oil shale and gas shale sectors. However, another argued that shale oil and shale gas is largely a US phenomenon, predicated on a set of US laws that could change rapidly. In addition, we may lack information on the technologies that companies could use to cut water use.

Recommendation: we recommend that we analyse beverage companies as our third sector (see section 5).

Methodology question 2

Should we develop the tool to analyse individual companies, or should we develop the tool to analyse archetypes for particular sectors?

The majority of participants seemed to support the idea that we develop a tool to analyse individual companies rather than archetypes. A few participants said that doing both might be best. One participant argued that even if we created archetypes on a sector by sector basis, our analysis would have to start at the individual company level. So there was a clear majority of participants in favour of company level analysis.

Recommendation: we recommend analysing companies not company 'archetypes'.

Methodology question 3

Should we explore further the technology costs of water efficiency/water supply augmentation (e.g. desalination) by sector?

There seemed to be a clear majority in favour of our looking at how companies might respond to higher water cost, by either investing in technology to "create" water, or to reduce water use. There seemed to be a consensus that we should look at the two or three ways that firms in particular sectors might spend money to escape higher water costs. However, there seemed to be little support for the idea of trying to develop cost curves.

One suggestion was that we could attempt to utilise work by Deane Dray, an equity analyst (now at RBC Capital Markets in New York, used to be at Citigroup) who has written about the technology side of water preservation. This will be included in the broader literature review we will do with regards to water efficiency technology and water creation, to inform our approach to modeling different ways of internalising higher water costs.

There was some debate as to how easy it would be to use desalination costs in our model. A consensus seemed to develop that desalination technology could be used, but that to understand that cost of desalination at any geography, one would need to be informed about energy costs at that locations, because desalination plants require a great amount of power. In addition, information about the distances that water might need to flow to the desalination plant might be required. One participant suggested that we might look at companies using "brackish water" in their operations as a low cost option for obtaining water.

Recommendation: we recommend modelling a few alternative technological responses to higher water prices, per sector. This could provide options for low and high-cost scenarios.

5 Choosing a Third Sector to Analyse

Both Beverages and Pulp and Paper have emerged as top candidates for the third sector to model, in addition to Mining and Power Generation. Modelling Beverages firms could entail an extra element of complexity, if we were able to input-output analysis to consider water extraction taking place upstream of the Beverage firm, i.e. along the firm's supply chain.

In choosing the economic sectors to analyse in this test phase we want to choose sectors that score highly in three regards, namely sectors that:

i) have a significant number of bonds outstanding
ii) are relatively heavily impacted by water stress
iii) for which there is a good data about their site locations and site water use

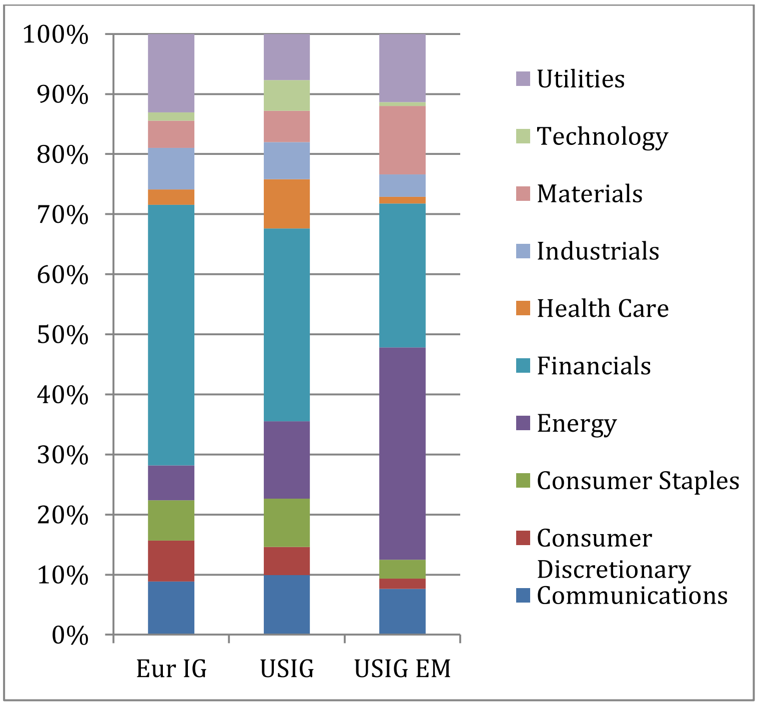
To check which sectors have a significant number of bonds outstanding, we look at the bonds holdings by sector in three Bloomberg corporate bonds indices; the Bloomberg:
-Euro Investment Grade Corporate bond index [ticker BERC]
-US Corporate Bond Index [ticker BUSC]
-USD Investment Grade Emerging Market Corporate Bond Index [ticker BIEM]

Each corporate bonds is classified to fall within one of ten categories: Communications; Consumer Discretionary; Consumer Staples; Energy; Financials; Health Care; Industrials; Materials; Technology; Utilities. We set out the percentages by business group, below.

Figure 1: Three Bloomberg Corporate Bond Indices, Broken Down by Industrial Sector

	Eur IG	US Corp	US IG EM
Communications	8.9%	9.9%	7.6%
Consumer Discretionary	6.8%	4.7%	1.7%
Consumer Staples	6.7%	8.0%	3.1%
Energy	5.8%	12.9%	35.3%
Financials	43.4%	32.1%	24.0%
Health Care	2.6%	8.2%	1.1%
Industrials	6.9%	6.2%	3.7%
Materials	4.5%	5.2%	11.4%
Technology	1.3%	5.1%	0.6%
Utilities	13.1%	7.7%	11.3%
Total	100.0%	100.0%	100.0%

Figure 2: Three Bloomberg Corporate Bond Indices, Broken Down by Industrial Sector



Mining and Pulp and Paper bonds fall within the Materials sector. Power generation bonds fall within the Utility sector. Food and beverages falls within the Consumer Staples sector.

Because Pulp and Paper companies are contained within the Materials section above, it is not completely clear as to whether there are more Beverage bonds outstanding in these indices or Pulp and Paper bonds. However, it is probable that there are more Beverage bonds, because the Consumer Staples category (within which we find Beverages) is bigger than Materials (where we find Pulp and Paper) in two out of the three indices.

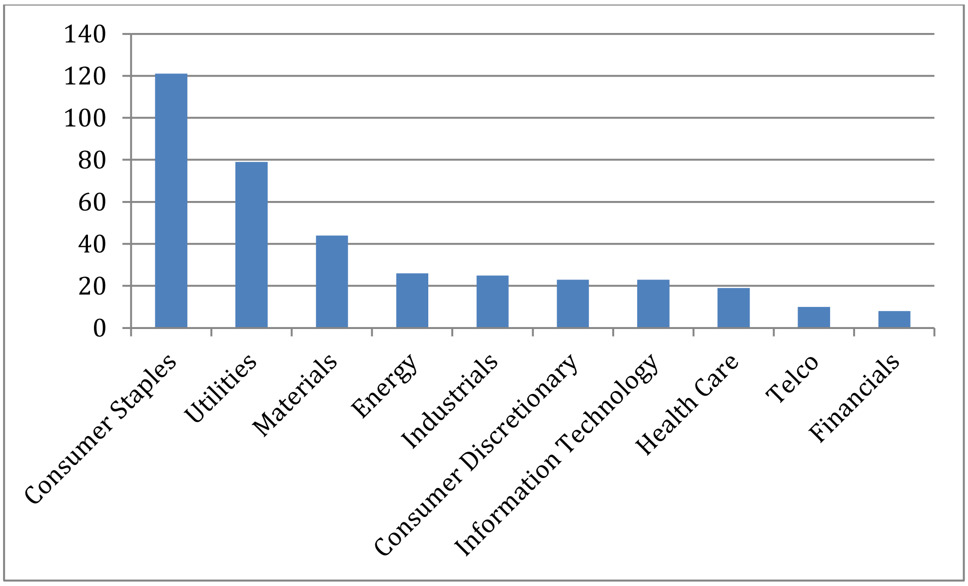
Below we present some basic information on seven companies operating in four sectors, namely mining, power generation, beverages and forestry, pulp and paper. We see that many Beverage firms listed below have more bonds outstanding than the Pulp and Paper firms.

Figure 3: Seven Companies in Four Industry Sub-Sectors, with Outstanding Bonds

Mining	HQ	Ticker	Moodys	S&P	Bonds	US$ Billion	
Anglo American	London, UK	AALLN	Baa2	BBB	20	14.96	
Consol Energy	Canonsburg, PA, USA	CNX	B1 Neg	BB	4	3.22	
Fortescue Metals	Perth, Australia	FMGAU	Ba1	BB+	4	3.90	
Glencore	Zug, Switzerland	GLENLN	NR	BBB	45	35.73	
Rio Tinto	London, UK	RIOLN	A3	A-	29	22.89	
Vale	Rio de Janeiro, Brazil	VALEBZ	Baa2 Pos	BBB+	8	11.55	
Vedanta	Mumbai, India	VEDLN	Ba3	BB	26	6.93	99.17
Power Generation							
EdF	Paris, France	EDF	Aa3Neg	A+	63	74.32	
Eskom	Johannesburg, SA	ESKOM	Ba1	BBB- Neg	19	14.29	
Israel Electrric	Tel Aviv, Israel	ISRELE	Baa3	BBB-	23	7.96	
RWE	Dusseldorf, Germany	RWE	Baa1	BBB+	13	15.31	
Southern Company	Atlanta, GA, USA	SO	Baa1	A Neg	159	22.09	
Taqa	Abu Dhabi, UAE	TAQAUH	A3	A-Pos	12	8.07	
Vattenfall	Stockholm, Sweden	VATFAL	A3	A-	21	8.85	150.88
Beverages							
Anheuser-Busch	Leuven, Belgium	ABIBB	A2 Pos	A	44	25.21	
Carlsberg	Copenhagen, Denmark	CARLB	Baa2	NR	4	4.82	
Coca Cola	Atlanta, GA, USA	KO	Aa3	AA	35	21.88	
Diageo	London, UK	DGELN	A3	A-	20	14.41	
Heineken	Amsterdam, Netherlands	HEIANA	Baa1	BBB+	22	10.76	
Nestle	Vevey, Switzerland	NESNVX	Aa2	AA	10	5.63	
SAB Miller	London, UK	SABLN	Baa1Pos	A-	16	13.25	95.95
Forestry, Pulp and Paper							
Fibria Celulosa	Sao Paolo, Brazil	FIBRBZ	Ba1 Pos	BB+	2	0.60	
International Paper	Memphis, TN, USA	IP	Baa2	BBB	89	8.86	
Mercer International	Vancouver, Canada	MERC	B2	B+	3	0.68	
Metsa Oyj	Metsa, Finland	METOSU	B1 Pos	B+	2	0.50	
Plum CreekTimberlands	Seattle, WA, USA	PCL	Baa2	BBB	3	1.36	
Sappi	Johannesburg, SA	SAPSJ	Ba2	BB	10	1.79	
UPM-Kymmene	Helsinki, Finland	UPMKYM	Ba1	BB+	4	1.05	14.84

How dependent are these ten different sectors on water use? If we include both direct and indirect water withdrawals, then we can say that the Consumer Staples sector (within which Beverages falls) is the most profligate, using 121 litres of water per US$ million revenues, followed by utilities (within which power generation falls) at 79 litres, with Materials (within which both Mining and Pulp and Paper fall), being the third most profligate at 44 litres. The full list is set out here and displayed in figure four: Consumer Staples 121 litres/US$ million sales, Utilities 79, Materials 44, Energy 26, Industrials 25, Consumer Discretionary 23, Information Technology 23, Health Care 19, Telecommunications 10 and Financials 8.

Figure 4: Direct and Indirect Water Withdrawals By Sector, Litres Per $Million Revenues



Source: "PRI Corporate Bonds, Spotlight on ESG Risks", PRI (Principles for Responsible Investment), page 9

While it is clear that both Beverages and Pulp/paper sectors are exposed to water scarcity risk, we recommend Beverages as the third sector, ahead of Pulp and Paper. There are two main reasons for this:

i) Beverage firms appear to have more bonds outstanding than Pulp and Paper firms;
ii) The level of water use by the sector is by some accounts larger than for Pulp and Paper.

6 Timetable

We see the project essentially involving three work streams, namely 1) undertaking the modelling, 2) developing the TEVs to feed into the modelling, 3) producing a report that would give both modelling conclusions (sections 1) and set out how was gathered and modelled by sector (section 2). Figure 5 sets out the deadlines for elements of these tasks.

Figure 5: Possible Timetable for Project

29-Dec	*	Fully evaluate feedback from Dec consultations
05-Jan		
12-Jan	*	Enter financial data into Excel model for all firms in the three sectors
19-Jan	*	Enter water data into Excel model
26-Jan	*	Enter location data that is available, into Excel model
02-Feb	*	Apply TEV values by location into Excel model
09-Feb	*	Develop sector capex responses to higher water costs
16-Feb		* Report section 1 – preliminary conclusions from early modelling
23-Feb		* Report section 2 – how we gathered data, modelled water stress
02-Mar		
09-Mar	***	2nd Workshop – 10 March
16-Mar		
23-Mar		

7 Data Providers

In our search for corporate data on water use at companies' locations, to date we have engaged in dialogue on data provision with four organisations, namely

- Bloomberg
- CDP
- GWI
- MSCI

An ideal data provider would provide us with full information about the location of a firm's operations, the firm's water use at these locations, as well as information about the production output (by product line) at these locations.

Bloomberg

Bloomberg provides a function whereby analysts can look at the World Resources Institute (WRI)'s water stress data, portrayed on a globe on the Bloomberg screen. Type BMAP <Return> on Bloomberg, then go to "Layer Lib [rary]", then go to WRI Aqueduct.

Bloomberg also provides a function whereby analyst can layer over this WRI Aqueduct map both the sites of mines and the sites of energy assets. However, as yet, Bloomberg does not provide locational data on pulp and paper sites or on food and beverage production sites.

Bloomberg also allows analysts to access a great deal of ESG information about companies listed on Bloomberg. When an analyst is looking at financial data about a company on Bloomberg, he or she can type FA ESG to access ESG information on that company, or FA ESGR to access ESG ratios on that company. He or she can also type FA CDP to access CDP (Carbon Disclosure Data) on that company.

CDP (Carbon Disclosure Programme)

The CDP sends out an annual questionnaire to water companies in five geographies: US, UK, South Africa, Australia and Japan, and to companies in the Fortune Global 500 (an annual ranking of the top 500 corporations worldwide by revenue, published annually by Fortune).

This questionnaire asks companies about their total water consumption per annum. However, this questionnaire does not produce information about water consumption at all of the firm's locations. The questionnaire asks companies to report locations at which it is facing water stress issues. Companies only then report information, quantitative and qualitative, for locations at which it self-reports problems.

Although CDP does not gather data from all of the locations of the firms they cover, some of the qualitative information that CDP gathers, addressing how companies respond to water stress, may inform our understanding of how firms respond to higher water prices. We have requested that CDP to provide us with information from companies in sectors of the GIC (Global Industry Classification) code, namely 1510.00, Materials; 2520.00, Consumer Durables and Apparel; 3020.00, Food, Beverages & Tobacco; 5510.00, Utilities.

Global Water Intelligence

Global Water Intelligence, based in Oxford, has some data on the price that some municipalities and cities around the world charge for their water. We might be able to use this data to compare the level of actual prices today in some urban areas, against the total economic value prices that we determine are appropriate for different locations on the globe. However, we would most likely have to purchase this data.

MSCI

MSCI is a provider of indices, ESG data/analysis and other products. They claim to have very good data on companies' ESG performance gathered from different sources. However, they do not consistently collect locational data on all of the companies that they cover. We are in contact with MSCI to understand more in detail, what data they can provide at what cost.

Sources of Information on Technology Costs

Given the FIs interest in our modelling how firms might respond to facing higher water prices, it is important to investigate the opex and capex opportunities available to companies in different sectors. We aim to investigate three or four different opex and capex opportunities available to companies in each sector and attempt to quantify their cost. For example in the Power Generation and Mining Sectors we can think of three or four different opportunities.

Power Generation

- water desalination
- using brackish water
- switch to renewable energy generation from thermal generation
- reduce water use by investing in cooling towers (as alternative to water cooling)

Mining

- water desalination
- using brackish water
- water efficient technology

Appendix One:
Integrating Water Stress into Corporate Bond Credit Analysis – Developing a Model Concept Note for Workshop – December 2014

This working paper outlines the steps we plan to undertake to integrate water stress into our credit analysis of companies.

We think we can come up with interesting results because we can integrate global level data (from the likes of WRI's Aqueduct study) about the level of water stress at different locations around the globe, both for today and for the future. At least for sectors like mining and utilities, we can then map information about the location of different companies operations, to this global level data.

So by knowing the location of a company, we can know whether this is located in a high water stress region of the world or not. Having done this, we can then look to create the appropriate water price that any company might have to pay, depending on whether its location was based in a region of water stress or not.

Performance indicators as a measure of management outcomes
While companies will have varied approaches to water management in response to water stress, the quantitative approach is based on the premise that actual levels of water use indicate company performance and the outcomes of any water management measures. Since scarcity is based on water use by all stakeholders, one company incrementally improving efficiency may not do much to alleviate their risk exposure in the water basin in the long-term. The aim of this tool is to identify which corporate bonds are most exposed to risk. Analysts can then focus on the high-risk companies to conduct further due diligence to evaluate and adjust for risk management if relevant. Further qualitative company- specific research could be undertaken to explore options for companies to improve water management in response to growing water stress, and to evaluate how companies are positioned strategically and operationally relative to sector peers.

Figure One: Combining Global Water Stress Data with Company Locational Data, Means That Firms' Financials Can Be Adjusted For Water Stress

- **Global level data** on water stress around the world
- **Company level data** giving location of company operations and water extraction/use data by company
- Model impact on **companies' financials** if use of water becomes restricted or water pricing is imposed
- Compare adjusted credit ratios with those required by the rating agencies

We do this analysis because we expect that companies are likely to face higher water charges from the governments' in whose region they operate. Inter-governmental organisations are recommending that water prices rise closer to the shadow price of water. If governments respond to these calls, either to reduce inefficiencies, or to reduce excessive water usage, then companies will be facing higher water charges.

A second reason we model higher water prices, is because companies might underestimate the cost of accessing water at sites where they operate. For instance, they might underestimate the variability of water resources due to the speed at which climate change impacts the area in which they operate. They might also underestimate the level of competition they face for water, competition coming from other firms in their sector active in this region, from the rise of other sectors (such as agriculture) active in the region, or from population growth. Where supply-side solutions alone are inadequate to address ever-increasing demands due to demographics, economic growth and changing environmental conditions, policymakers are likely to prioritise domestic and agricultural users over industrial users in water allocations, which require trade-offs between water users.

In attempting to undertake water modelling, we do this in the knowledge that location is a very important factor. The value of water becomes more important the scarcer it is in absolute figures, the more in demand it is in terms of demand versus supply in any location. And water becomes more valuable the greater the density of population living in any region.
We can illustrate the importance of location when modelling water extractions, by comparing the situation for water with that of air pollution.

When we try to assign costs to carbon dioxide (CO_2) emissions, because carbon dioxide is an uniformally dispersed pollutant, the location at which CO_2 emissions takes place is unimportant to the damage CO_2 emissions inflict, and therefore the appropriate cost to assign to each tonne of emissions. However, with an air pollutant like S0x, which is a non-uniformally dispersed pollutant, the location of any S0x emissions is very important in determining the amount of damage cause. So for example, a factory emitting S0x that stood up wind of a large city, would cause more overall pollution than a factory emitting S0x that stood up wind of a large ocean.

We mention this difference between $C0_2$ and S0x, because we see water extraction as comparable to S0x, rather than to $C0_2$. Location matters, and for this reason, the ability to map a company's locations against global information on water stress, is very important.
Having stated that location is very important when modelling water stress, please note that we undertake our modelling of companies and water stress in two distinct steps; and in the first step we make the simplifying assumption that location does not matter! This is an unrealistic assumption, but by making this assumption we are able to perform a first level analysis that brings concrete results to focus further analysis.

If we make this assumption, we then have to undertake the following steps. We access data on companies' annual level of water usage, in terms of m^3/annum (cubic metres per annum). We then assume a set cost, in term of US$/$m^3$, for this water usage. We then adjust the companies' financial ratios, taking into account these additional water costs. We calculate the firms' adjusted water costs and we compare these to ratios the rating agencies expect for any given credit rating that they might assign.

Example to illustrate

We look at three mining sector firms: Antofagasta, a Chilean copper miner; Rio Tinto, a London head quartered globally diversified miner, which nevertheless is heavily focused on iron ore production; and Vedanta, the Mumbai headquartered mining firm that produces iron ore, zinc, lead and copper.

We take data on water consumption by these companies from their annual reports. We then impose consecutively a water price of $1/m3, $5/m3 and $10/m3, to see how this impacts their financial ratios.

Before we impose these additional costs, we see that Vedanta is more highly leveraged than both Rio Tinto and Antofagasta. Vedanta had a gross debt/EBITDA ratio in 2013 of 3.33x. This is significantly higher than Rio Tinto's gross debt/EBITDA ratio of 1.26x and Antofagasta's even lower ratio of 0.51x.

When we consider these companies' water use, we find that Antofagasta has a far lower use water consumption ratio per $1,000 of revenues. For Rio Tinto this ratio in 2013 was 18.6 m3/$thousand revenues, and for Vedanta this was 31.3 m3/$thousand revenues, while for Antofagasta it was 7.5 m3/$thousand revenues.

When we introduce water costs, we see that Vedanta's financials, which are already the most highly geared of the three, see the greatest deterioration. If we assume each company pays $10/m3 for its water, then Antofagasta's gross debt/EBITDA rises to 0.61x, Rio Tinto's to 2.17x, and Vedanta's to 34.08x.

Figure Two: Financial Ratio for Three Mining Firms Assuming Water Prices of $1/m^3, $5/m^3 and $10/m^3

	Antofagasta	Rio Tinto	Vedanta
HQ	London	London	Mumbai
Operations	Chile	Global	India
Metals	Copper	Iron ore, diversified	Iron ore, zinc, lead, copper
Market Capitalisation, £ billion	£7.1 billlion	£55.7 billion	£2.1 billion
Credit Rating	(NR/NR)	(A3/A-)	(Ba1/BB)

	Antofagasta 2012	Antofagasta 2013	Rio Tinto 2012	Rio Tinto 2013	Vedanta 2012	Vedanta 2013
Revenues	6,740	5,972	50,942	51,171	14,640	12,945
EBITDA	3,864	2,702	20,291	22,672	4,909	4,491
Gross debt	1,889	1,374	26,904	28,551	14,158	14,950
EBITDA/Revenues	57.3%	45.3%	39.8%	44.3%	33.5%	34.7%
Gross debt/EBITDA	0.49	0.51	1.33	1.26	2.88	3.33
Water consumption; million m^3	46	45	1,396	952	406	405
Water consumption; m^3/$1,000 revenues	6.8	7.5	27.4	18.6	27.7	31.3
Assume water price of $1/m^3						
Adjusted EBITDA	3,819	2,658	18,895	21,720	4,503	4,086
Gross debt/adjusted EBITDA	0.49	0.52	1.42	1.31	3.14	3.66
Assume water price of $5/m^3						
Adjusted EBITDA	3,635	2,479	13,311	17,912	2,879	2,465
Gross debt/adjusted EBITDA	0.52	0.55	2.02	1.59	4.92	6.06
Assume water price of $10/m^3						
Adjusted EBITDA	3,406	2,256	6,331	13,152	850	439
Gross debt/adjusted EBITDA	0.55	0.61	4.25	2.17	16.66	34.08

(Source: Bloomberg and GCP)

In step two, we introduce location as a factor. To do this fully we would need to gather information on:

- the location of the firm's plants globally
- the level of water stress at each of these locations, in 2010 and 2020
- the firm's level of water use at that plant
- the firm's level of output at that plant
- the shadow price of water at each location

Ideally we would like to model a shadow price of water at that location, based in part on water stress (the relationship between water demand and water supply at that site), but also on other factors specific to that site, including factors like population living close to the site, and per capita income.

Using the above information, were it available, we would be able to calculate the price of water that the firm paid at each of its sites, and therefore a full operating cost level of additional water charges it would face, if shadow pricing was indeed introduced. We would then be able to calculate adjusted credit ratios for each company (as shown above). However, we do not yet have all of the information outlined above, in order to undertake this fully informed level of analysis. In the meantime, we present here a compromise method that utilises some information about the location of companies operations and whether they operate in regions of water stress.

For each of the three firms Antofagasta, Rio Tinto and Vedanta, we have information on the location of their mines. We also have information on the water stress (demand/supply ratio for water) in 2020 for each of these sites. We set out below information on Vedanta's eighteen mines, and compute a water stress ratio for each of these in 2020, which is simply expected water demand at that location in 2020 divided by expected water supply location in 2020.

Figure Three: Location of Vedanta's Mines, Water Supply and Demand Information in 2020, Plus Demand/Supply Ratio

Mine Name		Primary Metal	Country	Water demand 2020 optimistic	Water demand 2020 BAU	Water demand 2020 pessimistic	Water supply 2020 optimistic	Water supply 2020 BAU	Water supply 2020 pessimistic	Water Demand/Supply 2020
Bicholim Iron Ore Mine	15	Iron Ore	INDIA	0.071	0.072	0.070	1.056	1.080	1.080	0.07
Agnigundala Lead Mine	16	LEAD	INDIA	0.245	0.249	0.248	0.156	0.161	0.161	1.54
Surla Sonshi Iron Ore Mine	17	Iron Ore	INDIA	0.071	0.072	0.070	1.056	1.080	1.080	0.07
Chitradurga Iron Ore Mine	18	Iron Ore	INDIA	0.287	0.290	0.289	0.231	0.243	0.243	1.19
Colomba/Curpem Iron Ore Mines	19	Iron Ore	INDIA	0.064	0.064	0.063	1.212	1.239	1.239	0.05
Sonshi Iron Ore Mine	20	Iron Ore	INDIA	0.071	0.072	0.070	1.056	1.080	1.080	0.07
Codli Iron Ore Mines	21	Iron Ore	INDIA	0.071	0.072	0.070	1.056	1.080	1.080	0.07
Zawar Udaipur Lead/Z	22	LEAD	INDIA	0.161	0.162	0.160	0.275	0.277	0.277	0.59
Rajpura-Dariba Zinc	23	Zinc	INDIA	0.206	0.208	0.207	0.154	0.143	0.143	1.45
Kayar Zinc Deposit	24	Zinc	INDIA	0.172	0.173	0.173	0.081	0.076	0.076	2.27
Rampura-Agucha Lead	25	LEAD	INDIA	0.206	0.208	0.207	0.154	0.143	0.143	1.45
Mount Lyell Copper/G	26	Copper	AUSTRALIA	0.000	0.000	0.000	0.712	0.743	0.743	0.00
Skorpion Zinc Mine	27	Zinc	NAMIBIA	0.000	0.000	0.000	0.000	0.000	0.000	0.10
Nchanga Copper/Cobalt Mine	28	Copper	Zambia	0.021	0.021	0.020	0.466	0.468	0.468	0.05
Konkola Deep Copper Mine	29	Copper	Zambia	0.021	0.021	0.020	0.466	0.468	0.468	0.05
Nchanga UG Copper/Cobalt Mine	30	Copper	Zambia	0.021	0.021	0.020	0.466	0.468	0.468	0.05
Nchanga OP Copper/Cobalt Mine	31	Copper	Zambia	0.021	0.021	0.020	0.466	0.468	0.468	0.05
Konkola Copper/Cobalt Mine	32	Copper	Zambia	0.021	0.021	0.020	0.466	0.468	0.468	0.05

(Source: Bloomberg and GCP)

We define a location as suffering from "extreme water stress" if the ratio of water demand/water supply is greater than 2x. The location suffers from "water stress" if the water demand/water supply ratio is >0.5x by >2.0x. The location suffers from "limited water stress" if its water demand/supply ratio is >0.5x.

Using these definitions, we see that only one of Vedanta's eighteen mines (5.56%) suffers from extreme water stress, five out of fifteen mines (27.78%) from water stress and twelve out of eighteen mines (66.67%) from limited water stress.

We assign an overall water price to Vedanta that is set in relation to these proportions. We assume that the price of water at an extreme water stress site is $10/m^3; at a water stress site it is $5/m3 and at a limited water stress site it is $1/m^3.

As a result, we therefore settle upon a price of $2.61/m^3 for water for Vedanta. We come to this figure in the following way:

(0.0556 x 10) + (0.2778 x 5) + (0.6667 x 1) = 2.61

We undertake the same analysis for the two other firms Antofagasta and Rio Tinto.

Antofagasta

7 out of 21 mines	33.3%	are in areas of extreme water stress	(D/S>2)
7 out of 21 mines	33.3%	are in areas of water stress	(D/S>0.5)
7 out of 21 mines	33.3%	are in areas of limited water stress	(D/S<0.5)

Rio Tinto

5 out of 92 mines	5.4%	are in areas of extreme water stress	(D/S>2)
3 out of 92 mines	3.3%	are in areas of water stress	(D/S>0.5)
84 out of 92 mines	91.3%	are in areas of limited water stress	(D/S<0.5)

Vedanta

1 out of 18 mines	5.6%	are in areas of extreme water stress	(D/S>2)
5 out of 18 mines	27.8%	are in areas of water stress	(D/S>0.5)
12 out of 18 mines	66.7%	are in areas of limited water stress	(D/S<0.5)

As a result, we come out with prices of $5.28/m^3 for water for Antofagasta and $1.62/m^3 for Rio Tinto. We feed these water costs into our models for the three companies. We see that Antofagasta's gross debt/EBITDA ratio rises from 0.51x to 0.56x. Rio Tinto's ratio rises from 1.26x to 1.35x and Vedanta's from 3.33x to 4.35x.

Overall Antofagasta operates in areas of much higher water stress than either of the other two firms. Antofagasta is a copper miner operating in Chile and Pakistan. Water is much scarcer for Antofagasta than it is for Vedanta, operating in more verdant regions of India, and for Rio Tinto.

However, we find that although Antofagasta operates in regions of much more pronounced water stress, it uses far less water than either Rio Tinto or Vedanta. So although Antofagasta operates in more water stressed regions, because it uses water more sparingly, its financials do not deteriorate more rapidly than the other firms, when we introduce water pricing in line with the level of water stress experienced at each location.

What guidance are we seeking?
We are seeking guidance from financial institutions on three key issues.

1. Beyond the mining and power generation sectors, which third sector should be analyse in our testing phase through to March 2015?
2. Should we develop a tool that is used to analyse the impact of water stress on individual corporate bonds, or the impact on overall bond portfolio?
3. Should we do more work around the size and magnitude of water price rises that we introduce into our model, in particular in the field of technology costs, around desalination and possibly other water purification technologies?
4. Selecting sectors

First, we would like feedback on the sectors that we should analyse with this tool in our testing phase through to March 2015. We are proposing analysing mining sector companies and power generation companies. However, we would like to analyse a third sector, and we would like to receive thoughts from financial institutions on which sector to add to our analysis.

Below we set out criteria against which to judge whether economic sectors should be included in this study. We set out ten different sectors, namely telecoms, utilities, mining, energy, pulp and paper, aerospace and defense, food and beverages, retail and consumer, micro-electronics and agriculture.

We see six criteria as important to whether or not it should be included, namely:

- Is water capex/ opex rising?
- Are the production processes in the sector water intensive?
- Is the sector heavily reliant on bond financing
- Do bonds from this sector make up a significant proportion of any corporate bond portfolio?
- Is good information about the company's water use available?
- Does the sector have a short supply chain?

Figure Four: Criteria for Selecting Sectors to Analyse for Water Stress and Bond Valuations

	Telcos	Utility/ Power Generation	Metals/ Mining	Energy	Pulp & Paper	Industrials Aerospace & Defence	Industrials Food & Beverages	Industrials Retail & Consumer	Micro-electronics	Agri-culture
Water capex/opex rising	Y/N	Y	Y	Y	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N
Production process is water intensive	N	Y	Y	Y	Y	N	Y	Y	Y	Y
Sector heavily reliant on bond financing	Y	Y/N	Y	Y/N	Y	Y	Y	Y	N	N
Sector is large share of corp bond portfolio	Y	Y	Y	N	N	N	N	N	N	N
Good corporate water use data available	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	N
Sector has a short supply chain	Y	Y	Y	Y	Y	N	N	N	N	Y

Do you agree that the analysis should focus on sectors with the most number of affirmative answers to these questions?

Indicators to consider:

- High levels of absolute water use vs. water intensity (m^3/$mn revenue)
- Operational vs. supply chain water use.

It might be possible to analyse firms in sectors with long supply chains, such as firms in the aerospace and defence, food and beverage, retail and consumer and microelectronics sectors. However, it is worth pointing out that because of their long supply chains, an additional piece of input-output analysis would need to be undertaken to understand these firm's direct and indirect water use figures. This input-output analysis would be additional to the tool we are seeking to develop. Because we are working first and foremost to develop this initial tool, it might be best to choose as our third sector, a sector with a short supply chain, in other words a sector with similar supply characteristics to the mining and power generation sectors.

Please note that we have included “agriculture” as a possible sector to analyse. But it is important to note that this sector does not issue many corporate bonds. Companies like Cargill and Noble issue bonds, but these are really commodity trading houses, rather than agricultural fims. So we recommend against agriculture being chosen as a third sector.

Methodology/tool to analyse portfolio level exposure
The second question where we seek guidance is whether the tool we are developing should be a tool that can be used to analyse the credit quality of individual corporate bonds, or to analyse the credit quality of a portfolio of bonds.

We initially think that if we develop a tool to analyse individual corporate bonds, that we would then be able to use this subsequently to address the credit quality of a portfolio of bonds. However, it might be possible to directly develop a tool for analysing a portfolio of bonds, if we decide to analyse “archetypal” firms rather than real firms.

So for example, when we investigate the mining sector, instead of analysing 15 real companies, we could propose that the mining sector essentially consisted of say five different firm archetypes (e.g. dividing the sector up between say precious metal firms, iron ore firms, globally diversified, etc.). We could say how these five different archetype firms were impacted when water stress was factored into their financial analysis, stating which archetype might suffer rating agency downgrades, and by how much. This information could then be used by risk managers; they would determine what percentage of the mining sector bonds they held fell under each archetype, and then analyse the impact on their whole portfolio in this way.

Water pricing and technology costs
A third area where we might undertake more work, if requested, revolves around the appropriate level of pricing to introduce into our modelling work. The tool we are developing will allow analysts to enter water prices, as they see fit, into their credit evaluations of corporates. We are keen to offer analysts the opportunity to enter shadow prices for water, appropriate to the locations of the plants where the corporates in question operate. We think shadow pricing is the appropriate tool, as we expect pressure will mount on companies, from governments and from the international community, for companies raise their prices towards shadow prices.

In addition, we are also aiming to explore the feasibility of including technology costs, such as the cost of desalinated water at different locations, to inform our analysis: we could offer this price as an option when analysts wanted to specify by how much water prices might rise in different regions. However, we would be very happy to further investigate technology costs is participants suggest alternative water purification technology which they think will be commonly used in the near to medium term future. A range of potential technology costs could be used in scenario analysis/stress testing.

What might the tool actually look like?

The tool we are developing is likely to be Excel based. Users of the tool will be able to enter their own prices for water, in terms of $ per cubic metre. Alternatively, they would be able to model prices moving a certain percentage of the way toward the shadow price of water at the location in which a firm's plants operates. So an analyst might model a firm facing water charges that are 25% of the shadow price of water. Or the analyst would be able to model a firm facing water charges that are 50% of the shadow price of water, for example.

The outputs of the model would be adjusted financial ratios for the firm in question. These ratios would take the form of gross debt/EBITDA, net debt/EBITDA, Funds from Operations (FFO) to Gross debt and FFO to Net debt ratios, ratios that are used by the rating agencies to map a firm's financial performance to specific credit ratings. These ratios would give an insight as to whether firms face credit rating downgrades, if and when water pricing is introduced for the companies they analyse.

Open source data to be included in the tool:

- Geographical water scarcity and projected climate change impacts on precipitation (World Resources Institute/IPCC).
- Estimates of the shadow water values for each water basin to reflect levels of water stress.

Depending on the methodology approach developed, users would need to source the following additional data to apply the tool:

- Corporate data on water use (e.g. company reports, Bloomberg, CDP, Trucost)
- Corporate financial data (as above)
- Water pricing and technology costs (e.g. Global Water Intelligence, desk-based research).

The tool would bring together the above data and its application would provide analytics for stress testing/modelling of potential financial impacts of water scarcity. Financial institutions may develop their own internal systems to apply the recommended methodology(ies), or may integrate the tool into their processes for enhanced analysis.

Some thoughts on an additional piece of work

The work programme as set out above essentially attempts to develop a tool that can be used to integrate water risk into the analysis of corporate bond credit quality.

Attendees at the 8 December workshop might like to consider whether another piece of work should also be undertaken. It might be possible to attempt to identify the amount of water exposure that portfolio managers have in their portfolio of bonds.

We note that it is possible to calculate, for equity holders, the amount of carbon dioxide emissions for which they are "responsible", through their ownership of a portfolio of shares. An equity PM owning 10% of firm A's shares (which emitted 2,000 tonnes of CO2 per year), and 20% of firm B's shares (which emitted 5,000 tonnes of C02 per year), would be "accountable" for 1,200 tonnes of C02 emissions per year. The World Resources

Institute/World Business Council for Sustainable Development Greenhouse Gas Protocol provides high-level guidance on estimating emissions associated with financing.

However, the situation with regards bonds and water may be different for at least two reasons. First of all, bond holders do not have any ownership of a company. Ownership belongs wholly to the equity shareholders. [Although debt providers are responsible for a proportion of a firm's enterprise value, given that Enterprise Value = Market Capitalisation Plus Net Debt]. Second, water use is not necessarily a "bad" in the way that $C0_2$ emissions are a pollutant. Water use is only problematic in areas of scarcity. It is not problematic if its use does not lead to the reduction in water levels in aquifers. For this reason, just knowing the amount of water used by the firms in a bond holders' portfolio may not be very useful. It might be more useful to know the proportion of water use in areas of high water stress, rather than the absolute water level use, in a bond holder's portfolio.

One way to get around these two differences would be to try to consider the water exposure in a portfolio of bonds, in relation to a bond index against which the portfolio manager is being evaluated. If we would calculate the exposure to water use in areas of high water stress in a portfolio of bonds, and compare this to the exposure of water use in areas of high water stress in a bond index, this might provide some useful information; thought the exercise might involve a great deal of work for little additional insight.

Questions for discussion:

- Are the criteria for selecting sectors appropriate?
- Is the use of proxy data and shadow pricing adequate for inclusion in credit risk assessments /stress testing?
- Would access to water price data and technology costs be feasible for fixed income teams?
- Does the methodological approach strike a credible balance between granular company-specific analysis, evaluating corporate water use in the context of natural resource constraints, and taking into consideration the data/resource/time constraints of fixed income teams that would be expected to apply the methodology and/or tool?
- Would users be likely to integrate an Excel-based tool into existing processes or to adopt the methodology and develop internal systems to apply it?
- Would it be useful to allocate levels of corporate water use to a bond portfolio in proportion to corporate debt?